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THE

# *ANATOMY*

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OF THE

# HUMAN BODY.

VOL. II.

CONTAINING THE

## *ANATOMY*

OF THE

## HEART AND ARTERIES.

*By JOHN BELL*, Surgeon.

THE THIRD EDITION, CORRECTED.

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Ex Libris Medicus Gulielmus Moncreiff

## DR. JAMES JEFFRAY,

PROFESSOR OF ANATOMY IN THE UNIVERSITY

OF GLASGOW.

DEAR SIR,

WHEN this volume first appeared, you mentioned to me some doubts concerning the office which I hadascribed to the Eustachian valve. You proposed to publish some critical observations on this part of my Book, and, with a liberality becoming our common profession, and your high station in it, you spoke of addressing those strictures to myself.

It is no small gratification to me, that I have it now in my power to present a new Edition of this Volume, imperfect as it is, to one who allows it some merit, while he is yet not insensible to its defects.

 I believe

I believe you will accept with pleasure this slight testimony of respect and esteem, from one who can have no motive but respect and esteem for professing himself in this particular manner

Your most faithful and obedient
Humble Servant,
JOHN BELL.

# PREFACE.

THIS volume consists of two parts; the Anatomy and Physiology of the Heart—the Arrangements and Descriptions of all the Arteries of the Body.

THE discovery of the circulation of the blood has been always regarded as one of the most important, and has been ranked rather with the great doctrines of philosophy, than with the little discoveries in our peculiar science; it has been boasted of by our countrymen, and much coveted, and often claimed, by strangers. The discovery is most ingenious and beautiful, and is the foundation of all that physicians have thought or practised, right or wrong, useful or destructive, ever since.

How the well-proved doctrines of Harvey were perverted; what new, strange, monstrous, and impossible circles his antagonists contrived for the blood it were tedious to relate; but it is

most natural to mention why his doctrines were opposed. It was the universal opinion in those days, that the blood was formed in the liver, and sent out from it by all the veins to nourish the body, proceeding outwards during the day, and returning by night. The old physicians had thus entered into a train of thinking which it was not easy to change: these notions about the blood were become great and important doctrines, and had descended to them from their oldest teachers, with many weighty dependencies, conclusions, and rules of practice issuing from them: they were as articles of faith which it was a heresy to forsake; and it was easy to foresee, that should the Harveian doctrine prevail; should it be once completely proved that the blood moved outwards along the arteries and returned only by the veins; then all the reasonings of the physicians would be confounded; their theories embracing the whole body of physic disturbed; their system of practice entirely overthrown; and all that they had written themselves, and all the ancient books which they had read with so much diligence (for they were really learned); all that they had ever been proud of; was to be wiped out from the thoughts of that and of all succeeding ages!

But the doctrine of Harvey did at last prevail, dispelled those idle dreams of humours and temperaments, and spirits, and blood! of the blood concocted in the liver, and moving outwards along the veins to nourish the body; of the blood moving outwards during all the day, and returning by night; of the arteries earrying air only or vital spirits, to animate the system by mixing with the blood, while the veins alone eonveyed the proper blood. Yet this theory of the illustrious Harvey introduced general doctrines more mischievous in all their consequences than those which had just vanished: as, that the blood was composed of particular globules, the larger globules of smaller ones, and these again of globules of a third series; and that the arteries were so proportioned to the diameters of those globules, and descended by steps so regular and uniform, that each kind of artery had its peculiar globule which it received with ease, while others were rejected; or, if unhappily driven by a too violent aetion into vessels whieh they did not suit, were arrested in their progress; and produced either some local inflammation or some universal disease. These are the once famous doctrines of Malpighi,

Boerhaave, and all the great men of their day; and which they dilated into various forms, and adorned with the fine words of lentor, remora, error loci.

To these succeeded the mechanical physicians, who, by unintelligible problems of mathematics and algebra (reasonings which were ill-founded in their principles, even had the calculations been correct), pretended to estimate the force of the heart, the velocity of the blood, the power of the arteries, the strength of the veins, and the shape and size of each secreting orifice, according to the secretion which it had to perform. These were the doctrines, these the discoveries, which rendered famous the names of Bellini, Pitcairn, Keil, Hales, and other mechanical physicians, whose books are gone "to the vault of all the Capulets."

The chemists next soon turned their thoughts, from the vain search after the universal solvent and the philosopher's stone, to pharmacy and the useful arts. By the abilities and industry of Newman, this branch began to assume the more respectable appearance of a useful art; it began

began to be allied to science, and its connection with medicine was found to be of the most direct and important nature.

Having analysed the materials of the druggist, the chemists proceeded to analyse the parts of the human body to which those medicines were to be applied: but from this rational commencement followed one of the most trivial of all the miserable doctrines with which our science has been disgraced; for as the chemists had already explained the properties of the salts, metals, earths, and of all active substances, by the angles, cubes, or other forms which they saw their particles assume, they soon persuaded themselves that such forms as cubes, wedges, spiculæ, &c. existed in the blood; and acid and alkaline humours, sharp, corrosive, irritating, and pointed particles, were the terms in which they expressed their most admired theories; and acids, alkalis, and metals, and medicines for rounding the pointed particles, or obtunding (as they termed it), or sheathing, or covering the acrimonious humours, were their chief preventatives and cures.

Until

Until the present day this fault has pervaded all the great theories, that in describing our vessels physicians have continued to use the language of hydraulics and hydrostatics; of a philosophy applicable only to rigid tubes: in short, in describing the living system, they have forgotten that it was endowed with life.

We also may have erred in our turn: but with whatever degree of contempt we may view the doctrines of these older authors; or however succeeding generations may be amused with ours—still this is plain, that the most important facts in all anatomy, and the chief doctrines of the human body, must always accompany the explanation of those two great functions of the heart and lungs. Of course the constitution of the blood; the chemistry of airs; our dependence, so incessant and immediate, upon the atmosphere in which we live; the various and singular ways by which the fœtuses of different creatures, or the creatures themselves, according to their peculiar modes of life, draw their existence from the atmosphere; the various kinds of circulation by which this air is distributed through the system of each; the effects of air particularly

particularly upon our body; and the effects also of accidents, deformities, and diseases in those prime organs—all this wide circle of physiology belongs, in the strictest and clearest sense, to the anatomy of the heart. For one chief purpose in studying the anatomy of the human body is to understand its functions, and to compare them with those of other creatures, till we arrive at last at some distant conception of the whole; of the various structures of animals and vegetables; and of the various functions which in each of these classes support life, and action, and through it the principle of life.

There is no occasion on which this desire of knowledge, this willing admiration of the wonders of nature, is so strong as on first studying the functions of the lungs and heart; for upon the conjoined offices of the heart and lungs all perfect life seems to depend. And how universal these two functions are; how necessary to the support of the greater animals; how essential also to the constitution of the meanest insect —it shall be my business to explain.

The knowledge of the arteries again bears along with it the whole anatomy of the human body.

body. The nerves accompany the arteries, the lymphatics and veins twine round them; the glands and various organs are composed of them. The intimate structure of parts is known only by understanding the forms of their vessels; and as each individual part is nourished by arteries, he who has studied the arteries thoroughly, knows the whole.

But to the surgeon the knowledge of the arterial system is valuable beyond all calculation or belief. He performs no operation in which arteries are not engaged; he cures no great wound in which arteries are not first to be tied; he enters into no consultation in which the arteries are not first spoken of. Without a knowledge of the arteries he can neither think sensibly nor act safely.

Most unhappily all this comes to be known only at that period of life when the deepest conviction can produce only fear and perplexity, sorrow and regret. Yet, strange to tell, there is no such conviction; no regret, no irresolution, no perplexity, is ever seen! A surgeon, as ignorant of the blood-vessels as of every other point of anatomy,

anatomy, shall proceed in his operations with a forwardness and boldness terrible to those who know the danger; yet with a success and good fortune exceeding all belief.

The causes of all this are very plain. A relaxation in the discipline of the schools is the first cause—an indifference to anatomy, so marked and pointed, that an anatomical thesis in this country was never known. Every young man especially fears the difficulty of this part of anatomy, and shuns it. He is not duly impressed with such a high sense of its importance as to make labour pleasant; and when he is advanced to practice, he takes comfort daily from the mistakes and ignorance of others. A slender consolation! to see exemplified in others the faults and dangers to which we ourselves are exposed.

If these negligencies may stand excused on any account, it is on this only, That anatomists have been accustomed to write, not for the Public, in plain and simple language, but for each other, in an unknown tongue. By this I mean not a foreign or a dead language, but a peculiar style and phrase which no one can understand unless

unless he be initiated; unless he have studied the science itself so intensely, that he has also learned the jargon in which it is conveyed: in short, no one but a thorough anatomist can understand the language of anatomy, nor can even he understand it without some labour. Anatomists have buried their science under the rubbish of names; there is not a difficult or hard sounding word upon which they have any claim, that they have not retained: they have choked their subject with useless minutiæ, they have polluted their language, by transferring to it from Latin many words which, by their continual inflections in that language, were beautiful, while their unvaried, uncouth termination in ours, is barbarous in the utterance, while it tends but to interrupt and puzzle the sense: "They have impressed into the service of their science a great many poor words that would get their habeas corpus from any court in Christendom."

An anatomist, for example, will describe an artery as "going to the radial edge of the second metacarpal bone; then supplying the abductor and flexor muscles; then going along the bone of the first phalanx, seated upon this second metacarpal

metacarpal bone," with many other distortions, ambiguities, and little contrivances, to conceal (as one would believe) that he is describing so simple a matter as the artery of the fore-finger; which the reader at last finds out either by some lucky chance, or by reflecting how many metacarpal bones there are; and then reckoning them first forwards and then backwards, that he may be sure which it is that the author means; for his author may count from the little finger towards the thumb, or from the thumb towards the little finger, or he may have a fancy of leaving out the thumb, and reckoning only four. What must be the surprise of any well-educated young man when he reads in those books which he must study, of the regions of the elbow or thumb, or fore-finger? And if an anatomist understands such things with difficulty, how distressing must they be to the student?

This is the scholastic jargon which has so long been the pride of anatomists and the disgrace of their science; which has given young men a dislike for the most useful of all their studies; and which it is now full time to banish from our schools. These are the authors who avoid plain-

ness

ness as if it were meanness; who are studious of hard words as if they constituted the perfection of science : " it is their trade, it is their mystery, to write obscurely ;" and full sorely does the student feel it.

Want of arrangement, again, has still worse effects. Confusion is a monster in science; and Thomson has, in his Man of the Moon, described such a thing with great spirit and life : " A creature, if that may be called a creature which had no shape nor form, next rolled towards him, approaching still nearer and nearer, and by various glances and movements seemed to indicate a sympathy with man : it was a rude unformed mass; legs and arms, fingers and toes, and membranes and glands, and entrails and teeth, were blended into one abominable mass."

If I should tell my reader that there are very nearly one thousand arteries in the body, going promiscuously to bones, ligaments, bowels, and glands, muscles, and nerves, to a thousand unconnected difficult parts, all of which he must know by name, how would he be affected? But when I observe, that these go to the neck, the head, the

the arm, the leg, he begins to see this confusion of muscles, and glands, and bowels, vanish, and to perceive that all these arteries may be usefully and very simply arranged. When he is next taught to know the course of each greater artery, and the parts in which each division and branch of it lies, he perceives clearly that the parts through which it runs, as the arm-pit, neck, or groin, must limit and regulate the number of its branches, and give to each twig even an appropriate place and name: When next the whole arterial system is marked and chalked out for him in different portions; when there are points of peculiar importance set apart which he is charged to learn with particular care—he sees a good end in all this toil; he begins with courage, and gets forward easily; it becomes an interesting, and of course a pleasing, task. But still it is a task: and I entreat the young student, as he values his own honour, or the safety of his friends, not to bate himself one iota of the whole. Let him not take an indolent advantage of those arrangements, which are meant to promote his industry, not to prevent it. Let him not read only concerning the greater arteries, neglecting the smaller ones, but go through the whole piece of anatomy honestly and fairly. He will no doubt forget in time the smaller

 arteries;

arteries; but by having studied even them with diligence, he must remember the great and important arteries with a clearness of comprehension and arrangement, which those who have not gone thus honestly through the whole study can never attain. Let him also remember, that studies like these, well performed during his early years, do, like past dangers, or the remembrance of good deeds, give an ease and pleasure to his after life.

The arteries, I will now venture to say, should be with the surgeon as familiar as his name; and there is no argument which proves it more strongly than this, that a man of real learning, of sterling good-sense, of a clear head and steady hand, a man accomplished in all other respects, and fitted by nature and genius for performing the most difficult operations, if yet he want this part of knowledge, may, in one unhappy moment, do things which he must think of with horror during all his life. I know well how little such accidents are thought of, when at last the evil day comes. A surgeon hardly believes this strict knowledge of the arteries to be so great a point. In the midst of an operation, or in a common wound, it gives him no concern

to

to see arteries bleed which he did not look for; nor has he great reluctance to drive his needle among parts which he does not know. An artery bleeds, and he looks for it; he calls out at last to screw the tourniquet, and it stops; the tourniquet is loosened again, and again it bleeds; again the screw is tightened on account of the loss of blood; he expects to strike the artery; he is accustomed to strike it, not by knowing where it lies, but by seeing it bleed: at last some lucky dab of the needle succeeds, or perhaps from faintness of the patient the bleeding ceases: the surgeon is relieved from his present anxiety; but in a few hours he is called back to this scene of confusion and dismay: yet at last the bleeding is somehow or other mastered; and thus he gets on through all his difficulties, accident after accident, operation after operation, till at last he almost forgets that anatomy was a branch of his education, or the knowledge of blood-vessels necessary in operations or wounds.

I will not say that a man cannot suppress a bleeding from a wound in the arm, because he is not acquainted with the anatomy of the arm; but this surely I may be allowed to say, that it is

a piece of knowledge which at all times, but especially in those circumstances, can do no harm; and that if you leave a patient to choose betwixt two surgeons, one skilled in the knowledge of arteries, another knowing them only by seeing them spout out blood, it is easy to foretel where his choice will fall.

Perhaps some will be so hardened as to say, "and yet we seldom hear that patients die of bleeding." Is it then a merit that your patient is not plainly killed; that he does not expire under your hands? It is nothing to lose blood from day to day? Is it nothing that your patient is reduced to extreme weakness, suffering every thing but actual death? Is it nothing that he lies with tourniquets round the limbs in fear and anxiety, attended by young surgeons appointed to watch that bleeding, which may burst out while the patient turns in bed, and destroy him in one moment? Is it nothing to have fresh incisions and new searchings for the artery to endure?—These are real difficulties and dangers, and they should be provided for; our honour as well as our duty requires it. Bleeding from a great artery is to the patient the greatest danger: the very report of an ill accident is to the surgeon (though,

(though, God knows, he may be blameless) the greatest disgrace; and, lastly, though it should not be so, his taking up a bleeding artery dexterously and quickly, when others have failed, is a great honour.

When we think of all the important consequences of being thoroughly versed in this part of anatomy, they crowd upon our imagination more in number than can be even named. The surgeon may, indeed, provide for the arteries to be cut in a regular operation, by consulting books; but when he is called to a patient bleeding and faint, perhaps expiring, that person must live or die by his immediate skill! By his skill he will obtain the good opinion, not of ignorant attendants only, but of the profession: and by a bold and sensible conduct in any difficult situation he may give them a lesson of real use. Let us but for a moment think of the chances of those wounded in war;—the alarming, unthought-of accidents which overtake us daily in private life;—the wounds and hurts which workmen receive:—let us reflect on all the kinds of aneurism both in the heart and arteries, from wounds, from blows, from inward diseases:—let us think of all the various

rious operations in which arteries are concerned—and then declare whether, of all his studies, the young man should not value that most which makes him so immediately and eminently useful.

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## BOOK I.

## OF THE HEART.

### CHAP. I.

#### OF THE MECHANISM OF THE HEART.

THE heart is placed nearly in the centre of the human body, and is itself the centre of the circulating system. The system of vessels, which it excites and moves, consists of arteries and of veins;—the arteries act with great strength, with a pulsation like that of the heart itself, and convey the blood over all the body; the veins are in greater number, exceedingly large, pellucid almost in their coats, incapable of that energetic action with which all the functions of the arteries are performed; they return the blood to the heart with a slow, equable, and gentle motion, and deposite at the

right side a quantity of blood equal to that which is at each pulsation driven out from the left. The heart is placed betwixt the arteries and the veins, to regulate and enforce their action; to receive the blood from the veins by a slow dilatation, and to restore, by a sudden contraction, that force which the blood loses in passing round the circle of the body. But the heart has also another and more important office to perform; for by having two great cavities and two orders of vessels, it performs in the same instant two circulations, one for the lungs and one for the body; it receives from the lungs nothing but pure blood, it delivers out to the body nothing but what is fit for its uses: and this purifying or oxydation of the blood, and this excitement of the arteries, are two chief points of modern physiology, which every step of the following demonstration will tend to explain.

It will be most easy to conceive at first the idea of a more simple heart, of one circle, of one simple circulation; of one bag for receiving, and another joined to it for propelling, the blood. Indeed a heart consists merely of these essential parts; a GREAT VEIN, an AURICLE, a VENTRICLE, and a GREAT ARTERY: of a vein which returns the blood from all the body; of an auricle or smaller bag, which receives that blood and retains it till the action of the heart is relaxed; of a ventricle (which is the proper heart), strong, muscular, very irritable, and easily excited, into which the auricle pours its blood; of an artery which is allied to the ventricle in strength and action (as the auricle is to the vein in the delicacy of its coats), and which carries on the blood to the extremities of the body:—and the vein and artery meet-

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ing in all the extremities of the body, like various branches of one tube, the whole is a circle, and the heart is the central power.

If an animal do not breathe, its system will be what I have now described; it will have but one vein, one auricle, one ventricle, one artery; it will have one simple heart: but with us, and other breathing animals, it is not so; and I am now to describe a more complex and curious circulation. For suppose this blood so essential to our existence, to have in it some principle of life, which is continually lost, that principle must be continually renewed: the heart, which fills the arterial system, must not be taken from its appointed office, nor disturbed; nature appoints a second heart, which belongs entirely to this most important of all functions, viz. renewing the blood; and it may be renewed in many various ways. It might, for example, circulate in some peculiar viscus like the liver or spleen; in the fœtus it does circulate in such a mass, for the placenta is a thick and flat cake, whose office we know to be equivalent to that of the lungs, but whose structure we do not understand: in the chick we see its blood circulating over the yolk (for the yolk is inclosed within the membranes of the unhatched chick), and we perceive the blood redder as it returns to the heart, and plainly changed: in fish we find the blood circulated over the gills, exposed thoroughly to the water in which they swim, and thus the gills perform to them the function of lungs. But in all breathing creatures, the lungs do this office; the lungs are, next to the heart itself, essential to life; in those who die from bleeding, we can perceive

from the livor of the face; from the sobbing and struggles of the chest, from the regular convulsive sighs of those creatures which are butchered, rather a desire for air than a want of blood. It is for the purpose of this second circulation that nature has appointed in every breathing creature two hearts, a heart for the lungs, and a heart for the body; two veins, two auricles, two ventricles, and two great arteries, one the pulmonic artery, or artery of the lungs, the other the aorta, or artery of the body.

But still there are other varieties which distinguish animals into creatures of cold or of warm blood; for there are certain constitutions which do not require that the blood should be thus continually renewed. It is not because animals are amphibious, or go into the water, that they have peculiar lungs; for the Land Tortoise, the Newt, the Cameleon, never go into the water; yet they have membranous lungs: nor indeed can the Amphibiæ, as the Seal, the Porpoise, the Sea Lion, &c. dive longer than a man can do; though for whole days they lie in herds basking upon the shore; it is their peculiar constitution to need less than other creatures the office of the lungs. The cold-blooded animals are generally creeping animals, sluggish, languid, cold, inert, difficultly moved, and tenacious of life to a wonderful degree. They can bear all kinds of stimuli; they can bear to have their heads, legs, bowels, cut away; and among other peculiarities of this constitution, they can live long without air; they will rise from time to time above water, if you allow them; they can bear again to be kept under water, if you force them: but if they can live long under water,

ter, they can also live at least as long after you have cut off their heads, or cut out their hearts.

Of those cold-blooded creatures always either the heart or the arteries are peculiar; the heart is so in many amphibiæ, as in the Turtle, where the heart seems to consist of three ventricles, but with partitions so imperfect betwixt them that they are absolutely as one: this one ventricle gives out both the great arteries; the blood of the lungs and the blood of the body are both mixed in the heart; and since there are two arteries conveying this mixed blood, if the two arteries be nearly equal in size, then it is just one half of the blood thrown out by the heart at each stroke that receives the benefit of the lungs. In many others, as the Frog, the Newt, the Toad, the peculiarity is in the arteries alone; they have one single and beautiful heart; there is one large auricle as a reservoir for all the blood both of the body and of the lungs; there is one neat, small, and very powerful ventricle placed below the reservoir, having strength quite sufficient for moving both the blood of the lungs and the blood of the body; and this ventricle gives off an aorta, which soon divides into two branches, one for the body and one for the lungs; and these of course have but half the blood of this heart exposed to the air: these also are cold-blooded animals.

But all breathing creatures, such as are called animals of hot blood, have two hearts: the one heart is sending blood through the lungs while the other heart is pushing its blood over the body; not the half only, but the whole blood which is sent by each stroke of the heart over the body must have first passed through

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the lungs; no blood can reach the heart of the body which has not been sent to it through the lungs; or, in other words, the veins of the lungs, and they alone, feed the left side of the heart.

Words alone will never explain any of the endless difficulties which concern the mechanism of the heart; but at every point, in every kind of difficulty, in explaining the form, the parts, the posture, even the coats or coverings of the heart, I shall have recourse to plans, such as cannot fail to make all this intricate mechanism be easily conceived.

The most simple form of the heart, which is represented in the Plan, N°. 1. has a vein marked (*a*),—an auricle (*b*),—a ventricle (*c*),—an artery (*d*);—it has no provision for purifying the blood; it has no resemblance to that kind of heart which is connected with lungs; but the blood is received by the vein, falls into the auricle, is driven by its force into the ventricle, by the ventricle it is thrown into the artery, and courses round all the body, till at length, reaching the extremities of the veins, it passes by the veins to the auricle a second time, and so this single circle is perfect.

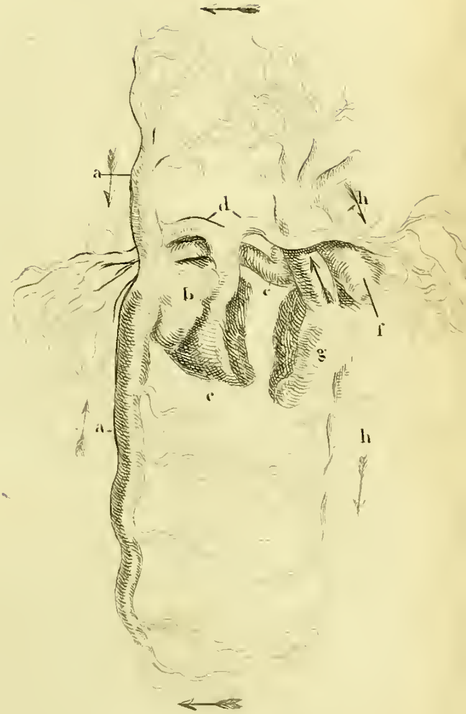
The heart of the amphibious creature is represented in N°. 2; it is a frog's heart: it has the most simple form, and the fewest parts; it has the same vein, auricle, ventricle, and artery; but its great artery divides into two chief branches, of which (*d*)—the aorta goes to the body,—(*e*) the pulmonic artery goes to each side of the lungs.

The heart of a breathing creature is represented in N°. 3. in its most intelligible form; and the double circulation

Plans of the Heart

No 1


No 3

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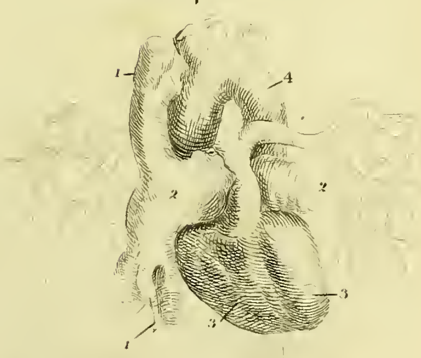


circulation of the human body may be traced easily in the following way.—Here the heart of the lungs is set off from the heart of the body, being as distinct in office as in form and parts; on the right side is the heart of the lungs, on the left side is the heart of the body. —(*a*) Is the great vein called VENA CAVA from its immense size;—there is an ascending and a descending cava; the one brings the blood from the head and arms, the other brings the blood from all the lower parts of the body; they meet at (*a*), and form by their dilatation there a chief part of that bag which is called the auricle,—in it they deposite all the returning blood of the body, and thus present it at the right side of the heart to be moved through the lungs.—(*b*) Is the RIGHT AURICLE; it is in part formed by a dilatation of these veins, but it puts on a strong and muscular nature as it approaches the heart; it is the first cavity of the heart, and, like all its parts, is strong and irritable; it is filled by the returning blood of the Cavas; it receives, dilates, is oppressed by this great quantity of blood; it is strongly excited to act; in its action the blood goes down into the ventricle or lower cavity of the heart.—(*c*) Is the RIGHT VENTRICLE, thick and strong in its walls, and of great muscular power; it is filled by the auricle, and is strongly stimulated both by the stroke of the auricle and by the weight and quantity, and also, in some degree, by the qualities, of the blood; its action is sudden and violent, and it drives the blood through all the system of the lungs.—(*d*) Is the PULMONIC ARTERY,—the artery of the lungs which receives all the blood of the right side of the heart; it is filled by the stroke of the right ventricle, from

 whose

whose cavity it arises; it carries the blood in many branches through all the substance of the lungs; and thus that blood which had returned imperfect and robbed of its vital quality to the right auricle of the heart, is by this circulation through the pulmonic artery ventilated and renewed, and made fit for the uses of the system; and thus the lesser circulation or the circulation of the lungs, the circulation of the right side of the heart, is completed, and the purified blood is brought round to the left side of the heart to undergo the greater circulation or the circulation of the body.

Thus it is from the extremities of this first circle that the second circle begins; it consists of like moving powers, of an auricle, ventricle, vein, and artery; for as the right heart receives the contaminated blood of the body from the veins of the body, the left heart receives the purified blood of the lungs from the veins of the lungs.—(*e*, Represents the VEINS OF THE LUNGS, which are sometimes three, sometimes four, in number; two enter from each side of the lungs, and return the blood purified in the lungs to the left auricle of the heart.—(*f*) Is the LEFT AURICLE, smaller, but more muscular and stronger than the right; it receives easily whatever quantity of blood the lungs convey to it, it is irritated, contracts, forces the mouth of the ventricle, and fills it with this purified and redder blood. —(*g*) Is the LEFT VENTRICLE, whose form is longer, its fleshy walls thicker, its cavity smaller, its power greater far than that of the right side; this ventricle is thus small that it may be easily filled and stimulated, and thus strong that it may propel all the blood of the

body

body.—(*h*) Is the AORTA or great artery of the body, arising from this left ventricle, just as the pulmonic artery arises from the right: the left ventricle, by its strong and sudden stroke, not only delivers itself of its own blood, but propels all the blood of the body; communicates its vibratory stroke to the extremest vessels, and excites the whole; this is the greater circle or circulation of the body, as opposed to the shorter circulation or lesser circle of the lungs.

That there are strictly two hearts, is now clearly made out; they are as different in form as in office; there are two distinct hearts, two systems of vessels, two kinds of blood, and two circulations. These two hearts might have done their offices, though placed in the opposite sides of the breast, it is in order to strengthen mutually the effect of each other that they are joined; for the fibres of the two hearts intermix; they are both inclosed in one membranous capsule, viz. the pericardium; the veins, auricles, ventricles, and arteries, correspond in time and action with each other, and harmonize in a very beautiful manner. But this, I believe, will be more easily explained by marking the succession of motions, by a suite of figures placed upon the several parts of the heart, by which the successive motions are performed.

In N° 4. I have joined the right and left hearts; both that it may be seen how the left heart locks in behind the right heart, how the right heart comes to be the anterior one, and how the aorta seems to arise from the centre of the heart while its root is covered by the great artery of the lungs; and also that the synchronous parts, *i. e.* the parts which beat time with each other, may be correctly seen.—1. The

CAVAS

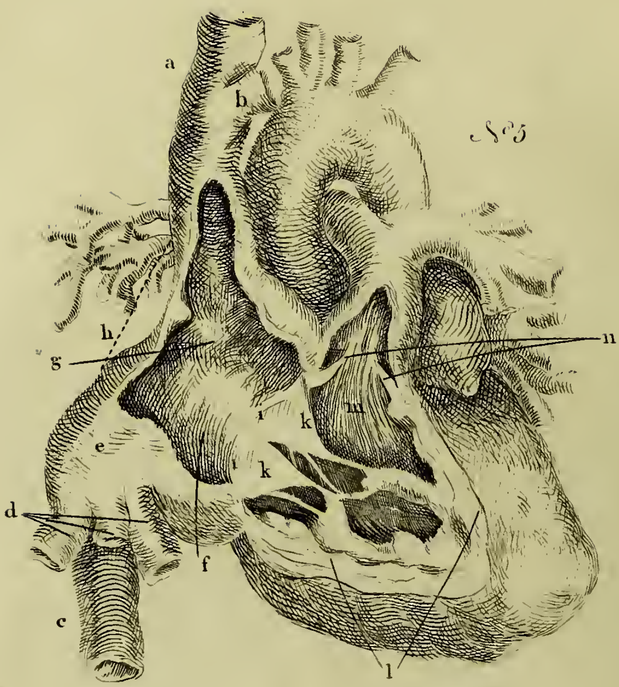
CAVAS are receiving the blood from all parts of the body, and in the same instant the pulmonic veins are receiving blood from the lungs. 2. The RIGHT AURICLE is gradually filling with the contaminated blood of the body; the left auricle, marked also with a second figure, is filling with purified blood from the lungs. 3. The RIGHT VENTRICLE is stimulated by its auricle, and throws its contaminated blood into the lungs; and in the same moment the left ventricle throws its purified blood over the body. 4. The PULMONIC ARTERY reacts upon the blood driven into it by the heart; and in the same moment the aorta reacts upon the blood thrown into it, and that reaction works it through all this great system of vessels from this the centre to all the extremities of the body.

Thus it is easy to perceive how the successive actions accompany each other in the opposite sides of the heart: 1. The two veins swell; 2. The two auricles are excited; 3. The two ventricles are filled with blood; 4. The two arteries take up and continue this pulsating action of the heart. It is thus that the two hearts assist and support the actions of each other, and there seems almost a physical necessity for their being joined; yet on the very best authority, and after deliberate dissection, we are entitled to affirm, that the heart is found, not with its apex sharp and conical, but cleft; the two ventricles plainly distinct from each other and divided by a great space. "Latro, quæ pœnas scelerum luebat, quando exenteraretur a carnifice, cor habuit singularis figuræ, mucrone non acuto, ut fieri solet, sed bifido; ut distincti ventriculi manifestius externa facie apparuerint, dexter nempe et sinister, interjecto magno hiatu*."

* Bartholini Epist. p. 107.

OF

№ 5

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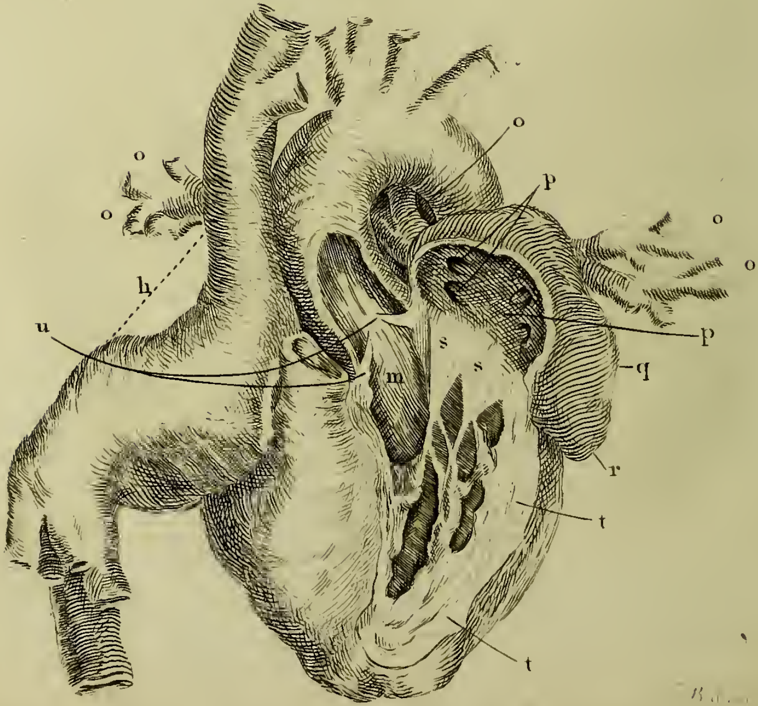


## OF THE PARTS OF THE HEART.

As yet I have explained only the general plan of the circulation, without having described those curious parts which are within the cavities of the heart, and which support the actions in this beautiful harmony and perfect order, each part subordinate to some other part, and each action succeeding some other action with perfect correctness, often without one unsteady motion or alarming pause, during the course of a long irregular life.

1. The VENÆ CAVÆ are two in number*; they are named venæ cavæ from their very great size; the one brings the blood from the upper, and the other from the lower parts of the body, and they are formed of these branches: the upper vena cava (*a*) is properly termed the DESCENDING CAVA, because it carries the blood of the head and arms downwards to the heart: this great vein is properly a continuation of the right jugular vein, which joins with the right axillary vein, and then descends into the chest a great trunk; and in the upper part of the chest it is joined at (*b*)—by a great branch, containing the axillary and jugular veins of the left side, which in order to reach the cava, crosses the

* Let the reader observe, that the whole of this description of the various parts of the heart is, as it were, an explanation of the plans N° 5. and 6.; of which the N° 5. shows the right side of the heart, or the heart of the lungs opened; while N° 6. shows only the left heart, or the heart of the body opened.

upper

upper part of the chest, and lies over the carotid arteries. The LOWER VENA CAVA, or CAVA ASCENDENS, brings in like manner all the blood from the belly and lower parts of the body by two great branches. One, marked (*c*),—is the great vein which lies in the belly along the left side of the spine, and brings the blood from the legs, the pelvis, and parts of generation, the kidneys, &c.; it is named the VENA CAVA ABDOMINALIS, because of its lying in the abdomen. Another, marked (*ddd*),—arises in three or four great branches from the liver; it is named the branches of the vena cava in the liver, or the VENA CAVA HEPATICA; and these two make up the lower cava; and the lower and the upper cavas now join themselves at (*e*)—to form the right sinus of the heart.

2. The RIGHT SINUS OF THE HEART marked (*e*), is of considerable extent; it is just the gradual dilatation of the two veins forming the auricle or reservoir, which is incessantly to supply the heart; the veins grow stronger as they approach the sinus, and the sinus still stronger as it approaches the AURICLE or notched and pendulous part (*f*), and the auricle again approaches in its nature to the ventricle of the heart; for it is crossed with very strong muscular fibres, which make very deep risings and furrows upon its inner part. To say that these veins, or the sinus which they form, are not muscular, merely because they are not red nor fleshy, is very ignorant; for t e ureters, urethra, arteries, intestines, the iris, and many other parts of the human body, are, at the same time, perfectly muscular and perfectly pale; and the heart of a fish is as transparent as a bubble of water, and yet is so irritable, that

that after it is brought from market, if you lay open the breast, and stimulate the heart with any sharp point, it will renew its contractions, and in some degree the circulation.

3. The TUBERCULUM LOWERI should be looked for in this point, if it were not really an imagination merely of that celebrated anatomist. The whole matter is this; the two veins meet, not directly, but at a considerable angle within the vein, as at (*g*). Lower conceived a projection of the inner coats of the vein at this point much more considerable than what I have here represented. It was thought to do the office of a valve, to break the force of the descending blood, to defend from pressure that blood which is ascending from the lower cava, and to direct the blood of the upper cava into the right auricle of the heart. But there is no such thing; although anatomists were at one time so fond of this trivial observation, that not one of them would demonstrate the heart, without demonstrating the tuberculum Loweri; whereas, if the blood of the lower cava needs any screen above it to defend it from the pressure, it is (as I shall show presently) quite of another kind; and in the place appointed for finding this tuberculum Loweri we can find nothing but on the inside the natural angle of the two veins, and on the outside some fat cushioned up in that angle in the line (*h*).

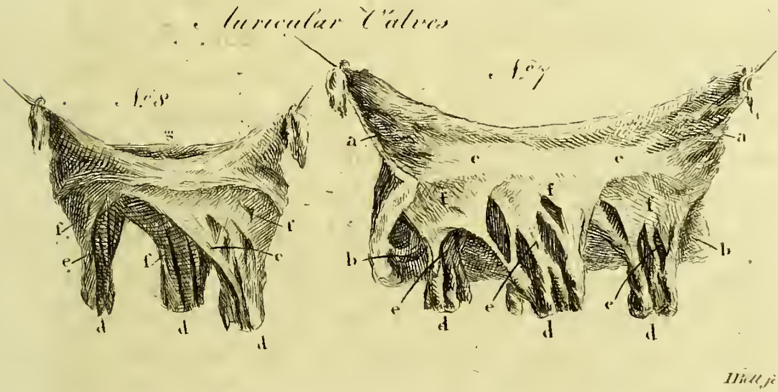
4. The AURICLE is, as I have said, a small appendix to the great bag or sinus, and is marked (*f*). It is small, semicircular, notched or scolloped, and somewhat like a dog's ear; whence its name. In general, we name the whole of this bag auricle; but by

by this plan the names of sinus and auricle must be easily understood. The point chiefly to be noted is this, that the veins, as they approach the auricle, are thin, delicate, transparent; that where they expand into the sinus they become fleshy, thick, and strong; that in the auricle itself the muscular fibres at *(f)* are very strong, have deep sulci like those of the ventricle, cross each other so as to make a net-work; and these strong fibres *(f)* are what are named the musculi pectinati auriculæ. Where these muscles run, as in cords, across the auricle they are very thick and opaque; but in the interstice of each stripe of muscular fibre, the auricle is perfectly and beautifully transparent, like the membranes of the veins; and these stripes of muscular fibre which are laid upon this thin membrane are almost as regular as the teeth of a comb; and thus they are named MUSCULI PECTINATI.

5. The VALVES of the AURICLE are placed at the circle (*i*), where the auricle enters into the ventricle, and the valves are marked (*k*): and how necessary these are for regulating the movements of the heart, will be easily understood by considering the conditions in which the auricle and ventricle act. First, The cavas pour in a flood of blood upon the sinus and auricle, with a continual pressure; the moment the auricle has contracted, it is full again; the pressure from behind excites it to act, and while it is acting there is no occasion for valves to guard those veins whose blood is pressing forwards continually, because they are continually full, and have behind them the whole pressure of the circulating blood. But when the auricle acts, it throws its blood into the ventricle, fills it,

and

and stimulates it; the auricle then lies quiescent for a moment, while it is gradually filling from behind with blood; but during this quiescent state the whole blood from the ventricle would rush back into it, were it not guarded by valves. The valves, then, which rise whenever the ventricle begins to act, are of this kind: There is, first, a tendinous circle or hole, by which the auricle communicates with the ventricle. The opening is large enough to admit two or three fingers to pass through it; it is smooth, seems tendinous, is



**Auricular Valves explained.**

Fig. 7. shows the Auricle and Ventricle cut open, and the valve hanging in three great divisions.—(*a*) Part of the inside of the Auricle.—(*b*) Part of the inside of the Ventricle.—(*c*) The Tendinous Circle from which the membrane of the valve arises.—(*d*) The Columnæ Carneæ.—(*e*) The Cordæ Tendineæ.—(*fff*) The three great divisions of the Valve.——N° 8. shows the circle of the entrance of the Auricle still entire; where—(*g*)—marks the entrance into the Auricle.—(*fff*) The three great divisions of the Valve.—(*d*) The Columnæ Carneæ; and—(*e*) The Cordæ Tendineæ.

is plainly the place of union betwixt the auricle and ventricle, which are in the fœtus (in the chick, for example) distinct bags; and from all the circle of this hole arises a membrane, thin, and apparently delicate, but really very strong; not divided into particular valves at this root or basis, but as the membrane hangs down into the ventricle, it grows thinner, and is divided into fringes. How these fringes can do the office of valves is next to be explained. The tags and fringes of this membrane are actually tied to the inside of the ventricle by many strings, which being, like the valves, of a tendinous nature, are called CORDÆ TENDINEÆ, or tendinous cords; and these cords being attached to little processes projecting from the muscular substance of the heart, these processes are named COLUMNÆ CARNEÆ, or fleshy columns. Of these tyings of the valves there are three chief points; the whole circle seems to be divided into three sharp pointed valves; they are named VALVULÆ TRICUSPIDES, or three-pointed, or they are still sometimes called Triglochine Valves. These strings and muscles cross each other; the valve at the left part of the circle is tied obliquely to the right side of the ventricle, and so on; so that by this crossing of their tendons the valves fall down easily when the blood goes down through them, and they rise readily and quickly whenever the blood gets behind them. The columnæ carneæ tie down the valves, so that when the ventricle acts the most strongly, they are the most strongly retained.

6. The VENTRICLE of the RIGHT SIDE (*ll*) is like its auricle, larger than the same parts on the left side;

for

for this auricle and ventricle of the right side have the weight of the whole blood of the body pressing upon them. They are subject to occasional fulness, for they must be dilated by many accidents, as labour, violent struggles, &c. which send the blood too quickly upon the heart; while the left auricle and ventricle, on the other hand, can never be overloaded, as long as the pulmonic artery preserves its natural size, for that artery continues always the measure of the quantity of blood which they receive. The ventricle is thick, strong, and fleshy. Its inner surfice is extremely irregular; it puts out from every part of its surface very strong fleshy columns. These fleshy columns are irregular in size, big, strong, running along the length of the ventricle; some cross the ventricle, so as to connect its opposite walls together; some have the tendons of the valves fixed to them; all of them have perfect contractile power, and are indeed the strongest muscles of the heart. Betwixt the fleshy columns, there are, of course, very deep and irregular grooves; and among the confused roots of these fleshy columns the blood often coagulates after death, seldom before it, into the form of what are called polipi of the heart. Yet still the walls of the right ventricle (*ll*)—are thinner, the fleshy columns smaller, the cavity greater, than those of the left side; the right ventricle of the heart has also a peculiar form, for the SEPTUM CORDIS, a partition betwixt the right and left heart, is not, as generally supposed, a part common to both; but the left ventricle is much longer, and more conical than the right one; the septum belongs almost entirely to the left ventricle; the right ventricle, which is much big-

ger, laxer, flatter, and thinner in the walls, is, as it were, wrapped round the left; and thus the left ventricle alone forms the acute apex of the heart, and the left ventricle of necessity bulges very much into the cavity of the right, since the right ventricle is so much larger, and in a manner wrapped round it. In both ventricles, it is very remarkable, that towards the opening of the auricle the surface of the ventricle is very rugged, irregular, and crossed with columnæ carneæ, while a smooth and even lubricated channel marked (*m*)—leads towards the artery.

7. The PULMONIC ARTERY arises from the right ventricle, to carry out the blood close by the great opening at which the auricle pours it in; the artery rises at its root in a very bulging triangular shape. It is the valve within the mouth of the artery that gives it this very peculiar shape without; for the bulging root is divided into three knobs, indicating the places of the three valves, the artery dilating behind each valve into a little bag, which when it is described, is called its sinus.

8. This VALVE of the PULMONIC ARTERY (*n*)—has a more perfect and simple form than that of the auricle. The valves in the mouth of each of the great arteries are three in number; they are thin but strong membranes, rising from the circle of the artery, where it comes off from the heart; each valve is semilunar; its larger and looser edge hangs free into the cavity of the artery; the edge is a little thicker than the rest of the valve; the three valves together form one perfect circle, which closes the mouth of the artery so that no grosser fluid, nor hardly air can pass.

When

When they are filled till they become very tense, each valve forms a kind of bag; so that when you look at the mouth of a dried artery, they appear like neat round bags; and when they are likely to be forced, the little horns or tags by which each valve is fixed into the coats of its artery, become so tense as to do the office of a ligament: these are called the SEMILUNAR or SIGMOID VALVES.

Now the condition of the ventricle while it is contracting is well understood: the auricle by its action lays down the tricuspid or auricular valve, and fills the ventricle; the ventricle cannot feel the stimulus of fulness till its valves rise and its cordæ tendineæ begin to pull; and the ventricle could not be close for acting, nor its walls perfect, it could not in short be an entire cavity, till the tricuspid or auricular valves were completely raised. But there is another opening of the ventricle, viz. that into the artery which must be also shut; this is one of the several instances of the subordination of these actions one to another; for first the auricle acts, then the ventricle, then the artery; so that the auricle and the artery are acting in the same moment of time; the artery by acting throws down its valve, and closes that opening of the ventricle, while the auricle is filling it with blood; and again, the moment that the ventricle is filled, both the auricle and artery are in a state of relaxation, both their valves yield, the auricular valve rises so as to close the ventricle on that side; and the arterial valve falls down, both because the artery has ceased acting, and because the valve is laid flat by the whole blood of the ventricle rushing through it. Hence it is very obvi-

 ous,

ous, that the right ventricle could neither be filled nor stimulated, unless the opening toward the artery were close during the time of its filling; and again, it is obvious that this valve cannot be laid down by any other power than that of the artery itself; who then can doubt that the artery has in itself (like the ventricle) a strong contractile power? That it is the stroke of the artery succeeding that of the heart that lays down this valve so closely, is proved by this, that in many animals, the Frog for example, the aorta is as plainly muscular as the heart itself, it is like a second heart; and in many creatures, as in fishes, and often in human monsters, the artery alone, by its own muscular power, moves the whole circulation without any communication with the heart. In fishes there is no second heart for the circulation of the body; and in monsters the heart is sometimes wanting, and there is found nothing but a strong aorta to supply its place. This stroke of the pulmonic artery, then, (which the heart excites,) pushes the blood through the lesser circle or circulation of the lungs, and by the pulmonic veins it is poured into the left side of the heart.

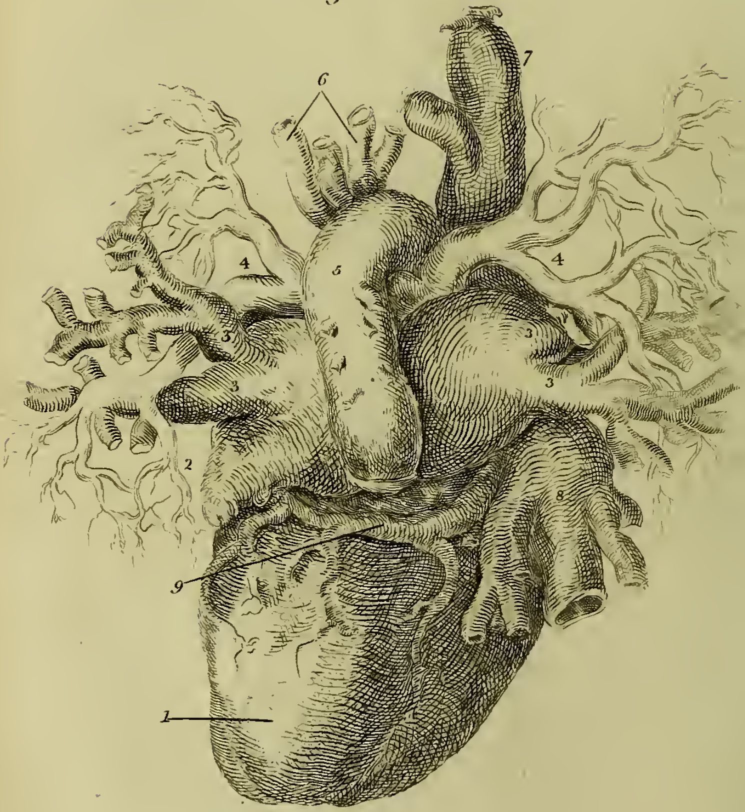
9. The LEFT AURICLE of the heart is unlike the right auricle in these respects: the sinus, or that part which consists of the dilatation of the pulmonic veins, is smaller, while the auricula, which is the more muscular part, is larger; the pulmonic veins come in four great trunks from the lungs, two from the right side and two from the left; two great veins then enter at each side of the left auricle, by which it gets a more square form; the whole of the left sinus, which forms

P. 2.

# Sketch

Representing the Backpart of the Heart — The great Coronary Vein — The Shape of the left Auricle — and the entrance of the Pulmonary Veins

No. 9




J. Bell fec.

the chief bulk of this part, is turned directly backwards towards the spine, and is not to be seen in any common view of the heart; but I have here added a plan of the back part of the heart*, showing, 1. How the left ventricle lies behind; 2. How the left auricle is turned still more directly backwards; 3. How the pulmonic veins enter into it in four great branches, so as to give a square or box-like form, compared with the gliding, gentle shape of the right auricle; 4. How the pulmonic artery comes out from under the arch of the aorta, dividing into its two great branches for each side of the lungs; and, 5. How the aorta arches over it, towers above all the other vessels, and is known always among the vessels of the heart, by the carotid and subclavian arteries, which come off from its arch. On the plan, N° 6. are seen—(*oo*) the two pulmonic veins entering from each side of the lungs—(*pp*) the opening of these into the auricle—(*qq*) the sinus formed in part by the dilatation of these veins, and—(*r*) the auricula or little ear, from which the whole bag is named auricle.

10. The valves which guard the left auricle are

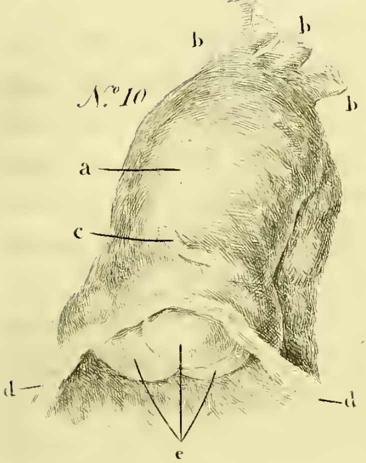
* Explanation of the BACK VIEW of the HEART, No 9.

1, The left Ventricle—2, The left Auricle—3 3 3 3, The four Pulmonic Veins—4 4, The two great branches of the Pulmonic Artery—5, The Aorta—6, The Carotids and Subclavians—7, The Cava Descendens—8, The Cava Ascendens, with all its branches from the Liver—9, The great Coronary Vein running along the back of the Heart betwixt the Auricle and Ventricle in a groove surrounded by fat.

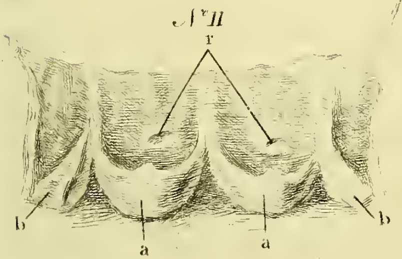
seen here* (*ss*):—Now it is to be remembered that the left auricle is smaller than the right, that the circle or opening of the left auricle is of course smaller than that of the right; that while it requires a valve divided into three points to fill the opening of the right auricle, a valve divided only into two points suffices for the opening of the left auricle: this is the reason of this slight variety of shape betwixt the two auricular valves, and is also the reason of the valve of the right side being called TRICUSPID or three-pointed, while this of the left side, from some very slight resemblance to a mitre, is named VALVULA MITRALIS, the MITRAL VALVE. In all other points this valve is the same with that of the right side, it has the same apparent thinness, for it is even transparent, the same real strength, the same COLUMNÆ CARNEÆ and tendinous strings to support it; the same rough irregular surface towards the opening of the auricle; the same smooth gutter leading towards the artery. The constitution of all these parts, in short, is expressly the same; so that even concerning the left ventricle there is nothing further to be observed, but that while it is much longer than the right ventricle, it is much smaller in its whole cavity, is much stronger in its COLUMNÆ CARNEÆ, and much thicker in its fleshy walls, as at (*tt*)—Where it is seen to be thicker than the right ventricle, it is indeed nearly three times as thick.

* This begins the description of the left side of the Heart, and the description follows the Plan, N° 6.

11. The




11. The SEMI-LUNAR VALVES of the aorta are also seen in this general plan at (*u*)—where manifestly the general structure and general intention of the valves are the same as in those of the pulmonic artery; but still we find at every point marks of superior strength and more violent action in the left side of the heart; for though this valve be expressly like that of the pulmonic artery, and named like it semilunar, yet it is thicker and stronger in its substance, and is peculiarly guarded by three small hard tubercles, which being placed one in the apex or point of each valve,



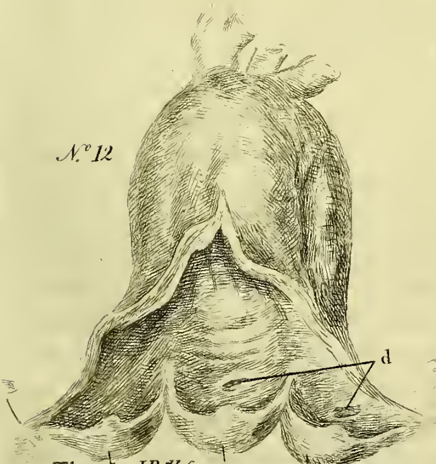




Fig. 10. shows the aorta entire, but its root within the heart opened so as to show its valve—*(a)* The body of the aorta; the arch is

valve, meet together when the valve is close, and give a more perfect resistance to the blood, and prevent the valve being forced open. These are to be seen chiefly in the marginal drawing, and from their being of the size of sesamum seed, they have the name of CORPORA SESAMOIDEA; sometimes they are named Corpuscula Aurantii.

12. The AORTA arises from its ventricle very large and strong; it swells still more at its root than the pulmonic artery does; the three subdivisions of this swelling, which mark the places of the semilunar valves, are very remarkable; the curvature at the arch of the aorta is called its great sinus, and these three smaller bags are called the three lesser sinuses of the aorta.

## *Of the* CORONARY VESSELS.

But there still remains to be explained that peculiar circulation by which the heart itself is nourished, and yet there is nothing in it very different from the usual form of arteries and veins; it is a part of the general circulation of the body, for the heart is nourished

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is marked by *bb*, the carotids and subclavians—(*c*) Shows one of the coronary arteries or artery of the heart.—(*d*) A part of the walls of the heart.—(*eee*) The three valves stuffed and turgid towards the heart.—N° 11. shows the lower part of the aorta cut open; and two of the valves—(*aa*)—entire; and the third valve—(*bb*)—cut in two by slitting up the artery.—And (*rr*) shows the mouths of the two coronary arteries.——N° 12. shows the aorta slit only in its lower part, and the valves (*aa*) and the mouths of the coronary arteries (*bb*) are seen in their natural situation.—*N. B.* In these two last drawings the corpora sesamoidea are distinctly seen in the central part of the edge of each valve, and they need no letter to distinguish them.

rished by the two first branches which the aorta gives off. The circulation destined for the nourishment of the heart is peculiar in this chiefly, that the forms of the arteries and veins of the heart are beautiful, and that the arteries rise just under the valves of the aorta, while the veins end with one great mouth in the right auricle. The coronary arteries are two in number, of the size of crow-quills; we see from the inside of the artery their mouths opening under the sigmoid valves. One artery comes from the lower side of the aorta; it lies towards the right; it belongs chiefly to the right ventricle; it comes out first betwixt the roots of the aorta and pulmonic arteries; it passes in the furrow betwixt the right ventricle and auricle, and turning round arrives at the back part of the heart, and runs down along the middle of that flat surface which lies upon the diaphragm; and when it arrives at the apex of the heart, its extreme arteries turn round the point and inosculate with the opposite coronary. The other coronary belongs in like manner to the left side of the heart, and arises from the upper side of the aorta; it first goes out betwixt the pulmonic artery and the left auricle, and then turning downwards upon the heart, it runs along that groove which is betwixt the ventricles, and marks the place of the partition or septum ventriculorum; its chief branches turn towards the left ventricle, and branch out upon it; it belongs as peculiarly to the left side of the heart as the other does to the right side: after supplying the left ventricle, &c. it turns over the point of the heart to meet the extremity of the first, and inosculate with it. Both these arteries give branches not only to the

the flesh of the heart, but also to the roots of the great arteries, constituting the VASA VASORUM, as such vessels are called.

The GREAT CORONARY VEIN which collects the blood of these arteries, arises in small branches all over the heart; these meet so as to form a trunk upon the fore-part of the heart, where the septum or union of the ventricles is. While small, the veins accompany their respective arteries; but after the great trunk is formed, the vein takes its own peculiar route. When the trunk of the great coronary vein (accompanied by several lesser veins) arrives at the auricle, it runs in between the left auricle and left ventricle; it turns all round the back of the auricle till it gets to the right side of the heart; it lies in the deep groove betwixt the auricle and ventricle, surrounded with much fat; and having almost entirely encircled the heart, it discharges its blood into the right auricle, close by the entrance of the lower cava. The opening is very large; it lies just above the tendinous circle of the auricle, and it is guarded with a strong semilunar valve. This is the great coronary vein: all the veins which appear upon the heart are but branches of it; what are called the MIDDLE vein of the heart, the vein of the right auricle, the vena innominata, &c. are all but branches of the great coronary vein running along the right side or lower surface of the heart; if there were to be any marked distinction, it should be into the GREAT CORONARY VEIN belonging to the left side of the heart, and the VENA INNOMINATA belonging to the right side. But one thing more is to be observed; viz. that upon the inner surface of the right auricle may be seen

seen many small oblique and very curious openings, which serve for the mouths of veins, while their obliquity performs the office of a valve This name of coronary vessels is a very favourite one with anatomists, and is applied wherever vessels surround the parts which they belong to, however little this encircling may be like a crown; and it is thus that we have the coronary arteries of the stomach, coronary arteries of the lips, and coronary arteries of the heart. But these vessels of the heart are really very beautiful, and have some things very peculiar in their circulation: first, with regard to the coronary arteries, they lie with their mouths under the sigmoid valves; or at least in so equivocal a manner, that their peculiar posture has given rise to violent disputes; viz. Whether they be filled, like all the other arteries, by the stroke of the heart, or whether they be covered by the valve so as to let the blood rush past them during the action of the heart.

We see the opening of the coronary arteries rather, as I imagine, under the valve; though Haller says they are above the valve, and that the highest point to which the margin of the valve reaches in very old men is below the opening of the coronary artery, and half way betwixt it and the bottom of the sinus or little bag behind the valve. But let this be as it will, if the condition of the aorta be considered, it will be found to make no difference; for though the valves rise and fall, are at one time fully opened, and at another time closely shut, still in both these conditions of the valve the aorta is as full as it can hold; its contraction instantaneously follows that of the heart, but its

contraction

contraction is not, like that of the heart, such as to bring its sides together; on the contrary, the aorta is full when the heart strikes, the action of the heart distends it to the greatest degree, the aorta reacts so as to free itself of this distention, but still it remains in some degree full of blood; else how could this, like every other artery, preserve always its form and apparent size? In this condition of matters, it is obvious that the coronary branches are on the same footing with all the other branches of the aortic system; that, like all the other arteries, they first feel the stimulus of fulness from the push of the heart, and along with it the stroke of the aorta.

Secondly, with regard to the coronary veins a dispute has arisen more violent than this; for it has been doubted whether the coronary veins, large as they are, do actually convey the whole of the blood which the coronary artery gives out. Veussens believed that some of the coronary arteries opened directly into the cavities of the heart, without the interposition of veins. Thebesius, after him, believed that there were some shorter veins by which the blood was returned, not by a long circle into the right auricle, but directly into the ventricles of the heart. Veussens, Thebesius, and others who belonged to their party, pretended to prove this fact by injections: But what doctrine is there which such clumsy anatomy and awkward injections may not be made to prove? They used mercury, tepid water, and air; and they forced these, the most penetrating of all injections, till they exuded upon the inner surface of the heart; but if they had fixed their tubes, not into the coronary artery, but into the aorta, and

and had proceeded to inspect, not the heart, but all the viscera of the body, they would have found their injections exuding from every surface; of the pleura, and lungs; of the peritoneum, and intestines; of the brain, and dura mater; of the mouth, and tongue; and universally through the cellular membrane of the whole body; but if any coarse injection, as tallow or wax, be used, it does not exude this way, but, following its natural course, keeps within the arteries and veins, and sometimes finds its way back to the auricle of the heart.

Du Verney was so far engaged in this question, that having an opportunity of dissecting the heart of an elephant, he tied up the coronary arteries and veins, washed and cleaned very thoroughly the cavities of the heart; and then tried, by squeezing, and all kinds of methods, to make that blood which was tied up in the coronary arteries and veins exude upon the inner surface of the heart, but with no effect.

On the present occasion, a theoretical answer happens to be as satisfactory as the most correct experiments; and it is this, If there really were to be formed (by disease for example) those numerous openings which Thebesius and Veussens describe, then the blood flowing all by these shorter and easier passages, none could come to the great coronary vein; its office would be annihilated, and itself, contracting gradually, would soon cease to exist.

### Of the Eustachian Valve.

There remains to be explained in the mechanism of the heart one point; and which I have separated from the

the others; not because it is the least important, but because it is the most difficult, and, if I may be allowed to say so, not yet thoroughly understood; I mean the anatomy of the EUSTACHIAN VALVE; which, if it had been easily described, should have been first described; for it is a valve which lies in the mouth of the lower cava just where that vein enters the right auricle of the heart. How imperfect a valve this is, how difficult to dissect or to explain, may easily be known from this, that Winslow was first incited to look for the valve by some hints in Sylvius; he was soon after fairly directed to it by finding it in the tables of the Eustachius, which were then first found and published by Lancisi, after the author had been dead 150 years; and yet with all this assistance Winslow sought for it continually in vain, till at last he reflected, that by cutting the heart in its fore-part he must have always in his dissections destroyed any such valve: by opening the back part of the cava he at last saw the valve, and demonstrated it to the Academy of Sciences in France; and having just received from Lancisi his edition of the Eustachian Table, so long hidden, and since so outrageously praised, he called it VALVULA EUSTACHIANA, a name which it has retained to this day, and he added RETICULARIS to express its lace-like netted appearance at its upper edge. From Winslow's time to this present day, that is, for eighty years, there has been no good drawing, nor even any perfect description of the valve; and, in the confusion of opinions upon the subject, what its use may be no one knows.

The Eustachian valve lies in the mouth of the ascending cava, just where that great vein is joined to the

the auricle of the heart. It looks as if formed merely by the vein entering at an acute angle, and by the inner edge of the vein, or that which is joined to the auricle, rising high, so as to do the office of a valve. The very first appearance of the valve, and its place just over the mouth of the cava, seems to point out that use which Lancisi has assigned it, viz. to support the blood of the upper cava, and prevent that column of blood which descends from the cava gravitating upon the opposite column which comes from the liver and lower parts of the body; and yet this, most likely, is not its use. The valve somewhat resembles a crescent, or the membrane called hymen. It occupies just that half of the cava which is nearest the auricle. Its deepest part hangs over the mouth of the cava, and is nearly half an inch in breadth, seldom more, often less, sometimes a mere line. Its two horns extend up along the sides of the auricle; the posterior horn arises from the left of the isthmus, as it is called, or edge of the oval hole; its anterior horn arises from the vena cava, where it joins the auricle. Behind the valve the remains of the foramen oval may be seen, now shut by its thin membrane, but still very easily distinguished; for its arch-like edges are so thick, strong, and muscular, that they look like two pillars, and thence are called the COLUMNÆ FORAMINIS OVALIS: these two pillars were called ISTHMUS VIESSENII, and by Haller are named ANNULUS FOSSÆ OVALIS, while the hole itself is so deep that it is named the FOSSA OVALIS. Before the Eustachian valve lies the great opening into the ventricle; but betwixt that and the valve there is a fossa or hollow, in which lies the opening of the great coronary vein; and the valve which covers the coronary vein is a

neat

neat small slip of white and very delicate membrane, the one end of which connects itself with the fore-part of the Eustachian valve; so that both valves are moved and made tense at once.

The Eustachian valve is in general thick and fleshy; it is sometimes reticulated or net-like even in the fœtus, but by no means so often as to vindicate Winslow, in adding reticulare to the name; it grows reticulated chiefly in the adult. The only beautiful drawing that we have of a reticular Eustachian valve is in Cowper; and that was from a man of eighty years of age. Perhaps in eight or ten hearts you will not find one that is reticulated in the least degree; in old men it is reticulated, just as all the other valves of the heart are, not by any thing peculiar to the constitution of this valve; not by the pressure of the blood and continual force of the vessels, as Haller represents; but by the gradual absorption which goes on in old age, and which spares not the very bones, for even they grow thin and in many places transparent.

This is the simple description of a valve, which has been the occasion of more controversy than the circulation of the fœtus and the use of the oval hole. Winslow first began about eighty years ago to observe the connections and uses of this valve: he laid it down as an absolute fact that this valve was almost peculiar to the fœtus; that it was perfect only while the foramen ovale was open; that it vanished gradually as the foramen ovale closed; that in the adult it was seldom seen unless the foramen ovale was also open by chance. It is incredible what numbers of anatomists followed this opinion; for the difficulty of dissecting the

the valve made it always easier to say that it was only in the fœtus that it could be found: it is also incredible what absurd consequences arose from this doctrine, which, after all, is but a dream, for in fact the valve is more easily shown in the adult heart*.

The foundation being now laid for connecting this valve with the peculiar circulation of the fœtus, they conceived the following theory, which has come down to this very day; viz. that in the child the great object of nature, in arranging its vessels, was to convey the blood which came fresh from the mother's system directly into the carotids, and so plump into the head at once. The pure blood from the mother comes through the liver by the ductus venosus; it is deposited in the lower cava at the right side of the heart; and these anatomists supposed that this current of fresh blood was directed by the Eustachian valve into the oval hole, through that into the left auricle and ventricle;

* One author, I find in the Acta Vindobonensia, is exceedingly angry indeed with all the great anatomists, for not connecting more strictly with each other the anatomy and accidents of the foramen ovale, and Eustachian valve; with Morgani, Albinus, and Wiedbriecht, he is offended for saying that they had seen the foramen ovale open, without saying one word concerning the state of this valve; and with Lieuteaud, Portal, and others again, he is equally offended that they should have had opportunities of seeing the Eustachian valve entire without inquiring into the condition of the oval hole. The reason of all this is very plain; the oval hole had not been open, neither in the one situation nor in the other, else it is very unlikely that such correct and anxious anatomists should have described that valve which arises from one of the borders of the oval hole, without observing it open, if it was so; especially as the oval hole, being open, is by no means an usual occurrence.

tricle, and from these directly into the aorta and carotids; while the foul blood of the upper cava went down into the right auricle and ventricle, and from that into the ductus arteriosus, and so away down to the lower and less noble parts of the body, and to the umbilical arteries, and so out of the system; for the ductus arteriosus, which comes from the right ventricle in the fœtus, joins the aorta only as it goes down the back, and none of its blood can pass upwards into the head.

This is the puerile theory, which, modified in various ways, has amused the French Academy, or rather been the cause of a perpetual civil war in it, for a hundred years. This doctrine began with Winslow, it is still acknowledged by Sabbatier; and Haller, after announcing a theory not at all differing from this, challenges it as his own theory; "hanc meam conjecturam etiam a Nichols video proponi." Of the truth of this theory Haller was so entirely satisfied, that he not only published it as peculiarly his own, but reclaimed it when he thought it in danger of being thus appropriated by another. Sabbatier is the last in this train of authors; and in order that there might remain no ambiguity in what they had said or meant, he pronounces plainly that the Eustachian valve is useful only in the fœtus, and that there are two opposite currents in the right auricle of the heart; that the one goes from the lower cava upwards to the foramen ovale, while the other from the upper cava descends right into the opening of the ventricle. What shall we say to anatomists who in the narrow circle of the auricle conceive two currents to cross each other

directly;

directly, and to keep as clear of each other as the arrows by which such currents are usually represented. This error in reasoning is below all criticism; it carries us backwards a hundred years in anatomy and in physics; and yet this is all that Winslow, Haller, Sabbatier, and a mob of others, have been able to say in proof of the connection of the Eustachian valve with the circulation of the fœtus.

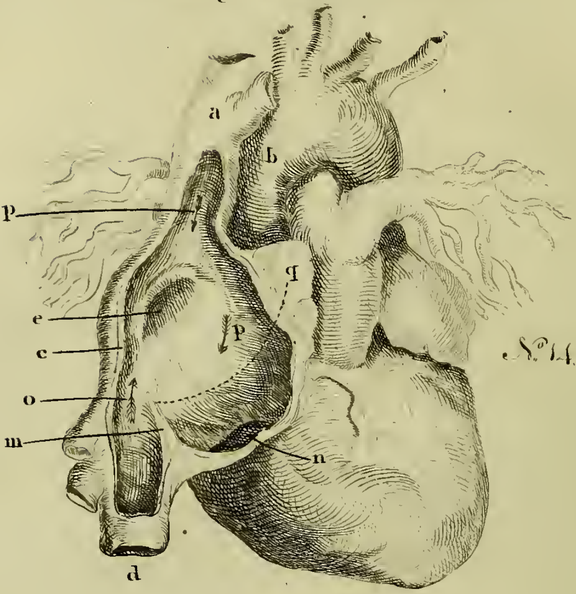
Lancisi, again, believed that it was chiefly useful by supporting the blood of the lower cava, defending it from the weight of that column of blood which is continually descending from above; and Winslow and others approved of this, as being perhaps one use of the valve. But they have all of them forgotten a little circumstance, which must affect the office of the valve, and which should have been regarded especially by those who said it was useful chiefly before birth; they have forgotten a little circumstance, which John Hunter also forgot, when theorizing about the gubernaculum testis, viz. that the child lies with its head downmost for nine months in the mother's womb.

Nothing is more certain than that the Eustachian valve is not peculiar to the fœtus; that it has no connection with the oval hole; that the valve is often particularly large after the foramen ovale is closed; that the valve is often obliterated where yet the foramen ovale remains open; that in adults it is more easily demonstrated than in children; that in old age it is often reticulated as the other valves are. Its use relates neither to the foramen ovale, nor to the ascending cava; it relates to the auricle itself, and therefore it is found

in all the stages of life, smaller or larger according to the size or form of the heart.

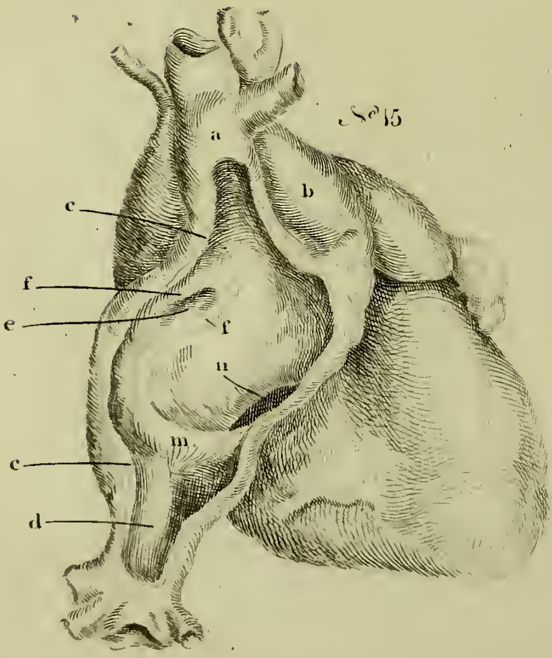
The auricle on the side towards the venæ cavæ is imperfect; the anterior part of the auricle chiefly is muscular, and when it contracts, the laxity of the cavas and the great width of the SINUS VENOSUS, *i. e.* of almost the whole auricle, would take away from its contraction all effect; but to prevent this, and to make the auricle perfect, the vena cava and auricle meet so obliquely, that the side of the cava makes a sort of wall for the auricle on that side. This wall has entirely and distinctly the reticulated structure of the auricle itself, with fleshy bands of muscular fibres in it: this wall falls loosely backwards when the auricle is quite relaxed, as, for example, when we lay it open; and thus it has got the appearance and name without the uses of a valve; but when the heart is entire, tense, and filled with blood, this valve represents truly a part of the side of the auricle: and that this part of the wall of the auricle should be occasionally a little higher or lower, looser or tenser, we need not be surprized. This further may be observed, that wherever, as in a child; this valve is very thin and delicate, the anterior part of the fossa ovalis goes round that side of the auricle particularly deep and strong. Let it also be remembered, that in certain animals this valve is particularly large and strong; now, in a creature which goes chiefly in a horizontal posture, it may strengthen and make up the walls of the auricle (the chief use which I have assigned for it in man); but surely it cannot protect the blood of the lower cava from the weight of blood coming from above, since the

# Plans of the Eustachian Valve

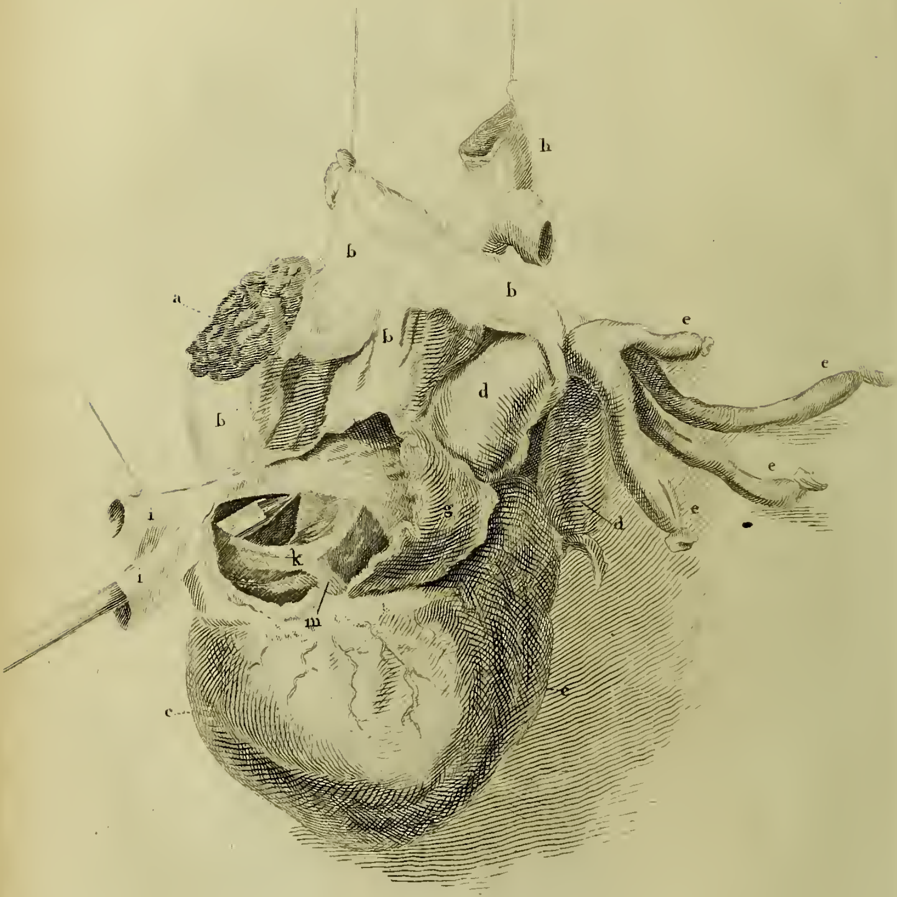



No. 14.

No. 15



Drawing of the Eustachian Valve
from the heart of a Child
about 3 or 4 years old




a.. A part of the Lungs. b.b. The Pericardium by which the Heart is suspended. c.c. The Ventricles of the Heart. d.d. The Aorta encircled by the Pericardium. e.e.e.e. The Subclavian and Caroted Arteries. g the Pendulous part of the Right Auricle h. The Cava descendens by &c. the Heart is in part suspended. ii. The Cava ascendens with a pencil passed up into the Right Auricle. this pencil is behind the Eustachian Valve The Eustachian Valve itself is marked k. The little Valve of the Coronary Vein which is connected with it is marked m.

...ll del. I.B...

the body of an animal lies horizontally, and there is no such weight. The Parisian academicians describe the heart of the Castor in the following terms: " Under the vena coronaria we find the valve called nobilis (viz. the Eustachian valve), which fills the whole trunk of the vena cava, and which is so disposed that the blood may be easily carried from the liver to the heart by the vena cava, but which is hindered from descending from the heart towards the liver through the same vein*."

* EUSTACHIAN VALVE.

N° 14. explains merely the place of the Eustachian valve, which is seen at (*m.*)—N° 15. explains both the place of the valve and its relation to the oval hole (*e*)—behind it, and to the mouth of the ventricle (*n*)—which lies before it.

In both these plans—(*a*) Is the cava descendens—(*b*) The aorta rising behind it—(*cc*) The back of the auricle slit open—(*d*) The cava ascendens, in the mouth of which the valve is—(*e*) The foramen ovale—(*ff*) Its two rising borders, named pillars, isthmus of Veussens, annulus ovalis, &c.—(*m*) The Eustachian valve, of which the two cornua, or sharp points, are seen in the lower plate, terminating in the pillars of the foramen ovale on one hand, and in the walls of the auricle on the other. The opening of the foramen ovale (*e*)—is behind and above the valve; the opening into the right ventricle (*n*)—is before and under the valve.

N° 14. explains more particularly the uses of the valve. Some authors conceived that it directed the blood rising in the line (*o*)—upwards into the oval hole; others that it directed the column of blood, represented by the arrow (*p*)—into the right ventricle; others that it protected the column (*o*)—from the weight of the column (*p*).—I rather suppose that it completes the auricle in the direction of the dotted line (*q*)—and so strengthens its action.

## Of the IRRITABILITY and ACTION of the HEART.

But even this curious mechanism of the heart is not more wonderful than its incessant action, which is supported by the continual influx of stimulant blood and by its high irritability and muscular power; for though we cannot directly trace the various courses of its muscular fibres, there is not in the human body any part in which the muscular substance is so dense and strong. In the heart there can be no direct or straight fibres; for let them go off from the basis of the heart in what direction they may, still as they belong to the one or the other ventricle, they must, by following the course and shape of that ventricle, form an oblique line. Vasalius has indeed not represented them so, he has drawn straight fibres only; because in the latter end of his great work he was without human subjects, and betook himself to drawing from beasts.

The fibres of the heart are all oblique, or spiral, some lying almost transverse; they all arise from a sort of tendinous line which unites the auricle to the ventricle; they wind spirally down the surface till the fibres of the opposite ventricles meet in the septum and in the apex of the heart. The fibres of each ventricle pass over the convex or upper surface of the heart, then over the apex, and then ascend along the flat side of the heart, which lies upon the diaphragm, till they again reach the basis of the heart. The second layer or stratum of fibres is also oblique; yet many of the fibres run alnost transversely, uniting the oblique fibres; but when we go down into the thick substance of the heart, we find its fibres all

all mixed, crossed, and reticulated in a most surprising manner; so that we at once perceive both that it is the strongest muscle in the body, and that the attempt to extricate its fibres is quite absurd *. Their desire of giving more correct and regular descriptions has been the cause why those who have particularly studied this point have been fatigued and disappointed; the most sensible of them have acknowledged with Vasalius, Albinus, and Haller, that the thing could not be done; while those, again, who pretended to particular accuracy, and who have drawn the fibres of the heart, have represented to us such extravagant, gross, and preposterous things, as have satisfied us more than their most ingenuous acknowledgements could have done, that they also could accomplish nothing.

There is no question that irritability is variously bestowed in various creatures, that it is variously appointed in various parts of the body, that this property rises and falls in disease and health; without hesitation we also may pronounce that the heart is in all creatures the most irritable part; it is the part first to live and the last to die; "Pulsus et vita pari ambulant passu." When we see the punctum saliens in the chick, we know that there is life; and when we open either the human body or the body of an animal soon after death, still the heart is irritable and contracts.

* Thickening the walls of the heart by vinegar, strong acids, alum, or boiling the heart, have assisted us in unravelling its structure but very little.

In the very first days in which the heart appears in the chick, while yet its parts are not distinguished, and the punctum saliens is the only name we can give it, the heart, even in this state feels the slightest change of heat or cold; it is roused by heat, it languishes when cold, it is excited when heated again. It is stimulated by sharp points or acids, it works under such stimuli with a violent and perturbed motion. In all creatures it survives for a long while the death of the body; for when the creature has died, and the breathing and pulse have long ceased, and the body is cold, when the other muscles of the body are rigid, when the stomach has ceased to feel, when the bowels which preserve their contractile power the longest have ceased to roll, and they also feel stimuli no more, still the heart preserves its irritability; it preserves it when torn from the body and laid out upon the table; heat, caustics, sharp points, excite it to move again.

We know also another thing very peculiar concerning the irritability of this organ, viz. that it is more irritable on its internal than on its external surface; for if instead of cutting out the heart we leave it connected with the body, seek out (as the old anatomists were wont to do) the thoracic duct, or pierce any great vein, and blow a bubble of air into the heart, it pursues it from auricle to ventricle, and from ventricle to auricle again, till, wearied and exhausted with this alternate action, it ceases at last, but still new stimuli will renew its force.

Thus it is long after apparent drowning or other suffocation before the principle of life is gone; and long after the death of the body before the heart be

dead;

dead; and just as in this peculiar part of the system irritability is in high proportion, there are in the scale of existence certain animals endowed in a wonderful degree with this principle of life. They are chiefly the amphibious creatures, as they are called, needing little air, which have this power of retaining life; no stimuli seem to exhaust them, there seems especially to be no end to the action of their heart; a Newt's or a Toad's heart beats for days after the creature dies; a Frog, while used in experiments, is often neglected and forgotten, its limbs mangled, and its head gone, perhaps its spinal marrow cut across, and yet for a whole night and a day its heart does not cease beating, and continues obedient to stimuli for a still longer time. It seems as if nothing but the loss of organization could make this irritable muscle cease to act; or rather it seems as if even some degree of deranged organization could be restored: breathe upon a heart which has ceased to act, and even that gentle degree of heat and moisture will restore its action. Dr. Gardiner having left a Turtle's heart neglected in a handkerchief, he found it quite dry and shrivelled, but by soaking it in tepid water its plumpness and contractility were restored.

Since then this irritable power supports itself in parts long after they are severed from the body, what doubt should we have that there is in the muscular fibre some innate contractile power or vis insita independant of nerves? And when we talk on a subject so difficult and so abstruse, what other proof can we expect or wish for than the power of one peculiar and insulated muscle surviving the separation of the

head,

head and brain, the destruction of its nerves, or its total separation from that living system to which it belongs? If the heart be the most irritable muscle of the body, if all this irritability arise from the nerves, how can it be that this muscle, which is thus announced as the most dependent on its nerves, is really the most independent? that the muscle which of all the body needs this nervous supply oftenest should want it the least, and should survive the loss of its nerves so much longer than the other muscles of the same body?

Although the ancients knew how irritable the heart was, although they often opened living creatures, and saw the heart struggling to relieve itself, because it was oppressed with blood, yet they continued entirely ignorant of the cause: and why the heart should alternately contract and relax without stop or interruption, seemed to them the most inexplicable thing in nature. Hippocrates ascribed it to the innate fire that is in the heart; Sylvius said, that the old and alkaline blood in the heart mixing with the new and acid chyle, and with the pancreatic lymph, produced a ferment there; Swammerdam, Pitcairn, and Freind, thought that the heart, and every muscle which had no antagonist muscle, was moved by a less proportion of the vital spirit than other muscles required. Others believed that each contraction of a muscle compressed the nerves of that muscle, and each relaxation relieved it; and that this alternate compression and relief of the nerve was the cause of the alternate movements of the heart: another physician of our own country, a great mechanic and a profound scholar in mathematics,

mathematics, and all those parts of science which have nothing to do with the philosophy of the human body, refined upon this theory most elegantly; for observing that the nerves of the heart turned round the aorta, and passed down betwixt it and the pulmonic artery, he explained the matter thus: "These great arteries, every time they are full, will compress the nerves of the heart, and so stop this nervous fluid, and every time they are emptied (a thing which he chose to take for granted, for in truth they never are emptied), they must leave the nerves free, and let the nervous fluid pass down to move the heart."

Des Cartes, who studied every thing like a right philosopher of the old breed, viz. by conjecture alone, supposed that a small quantity of blood remained in the ventricle after each stroke of the heart; which drop of blood fermented, became a sort of leaven, and operated upon the next blood that came into the heart "like vitriol upon tartar;" so that every successive drop of blood which fell into the ventricle swelled and puffed up so suddenly as to distend the heart, and then burst out by the aorta. Philosophers have been so bewitched with the desire of explaining the phenomena of the human body, but without diligence enough to study its structure, that from Aristotle to Buffon, it is all the same, great ignorance and great presumption. But on this subject of the pulse of the heart, physicians almost surpassed the philosophers in the absurdity of their theories, till at last they were reduced to the sad dilemma of either giving up speaking upon this favourite subject, or of contenting themselves with saying, "that the heart beat by its facultas pulsifica,

pulsifica, its pulsative faculty ;" as if they had said, the jaws chew by their mandicative faculty, and the bladder pisses by its expulsive faculty, and the womb expels children by its parturient power.

The ancients, I have said, often opened living creatures, and saw the heart struggling to relieve itself because it was oppressed with blood: this blood is itself the stimulus which moves the whole; for important as this function is, it is equally simple with all the others: and as urine is the stimulus to the bladder, food an excitement to the intestines, and the full grown fœtus a stimulus to the womb!—so is blood the true stimulus to the heart. When the blood rushes into the heart, the heart is excited and acts; when it has expelled that blood, it lies quiescent for a time; when blood rushes in anew, it is roused again: so natural is both the incessant action and regular alternation of contraction and relaxation in the heart.

It is when we are so cruel as to open a living creature that we see best both the operation of the blood as a stimulus, and the manner in which the heart reacts upon it. When we tie the two vena cavas so as to prevent the blood from arriving at the heart, the heart stops; when we slacken our ligatures and let in the blood, it moves again; when we tie the aorta, the left ventricle being full of blood will continue struggling, bending, turning up its apex, and contracting incessantly and strongly, and will continue this struggle long after the other parts have lost their powers. One author, whether from his awkwardness or the delicacy of the subject, or really from the strength of the ventricle, assures us, that often while he

he has held the aorta of a Frog close with pincers, it has burst by the mere force of the heart. If, after violent struggles of this kind, you cut the aorta, even of so small a creature as an Eel, it will throw its blood to the distance of three or four inches.

Thus we not only know that we can excite the heart by accumulating blood in it, but that by confining the blood in it we can carry that excitement to a very high degree; and in short, by keeping the one or the other ventricle incessantly full of blood, we can make the one heart work continually, while the other lies quiet, or is only slightly drawn by the other's motion, showing the true distinction betwixt the heart of the body and the heart of the lungs. And this is a memorable fact, that it is not merely the stimulus of the blood, but the sense of fulness that makes the heart contract; for the auricle often beats twice or thrice, sometimes it makes its push four or five times, before it can force the ventricle to contract.

When we empty the heart, and tie all its veins, all its parts cease to act; stimuli applied outwardly make it contract partially; it trembles in particular fibres: but it is only letting in the blood, or blowing it up with air, that can bring it into full action again. When we look with cruel deliberation upon the strokes of the heart in any living creature, we observe that at first, during the full and rapid action of the heart, there is hardly any perceptible interval among the several parts; but towards the end of each experiment, when the pulse flags, and the creature falls low, the swelling of the great veins, and the successive strokes of auricle and ventricle, are distinctly told. The dilatation

latation and contraction of each part is what we cannot observe, they are so quick; but these things we distinctly observe: The auricle contracts and dilates the ventricle; the ventricle contracts, subsides, and fills the aorta; the aorta turns and twists with the force of the blood driven into it, and by its own re-action; and the ventricle, every time that it contracts, assumes a form slightly curved, the point turning up like a tongue towards the basis, and the basis in some degree bending towards the point. The basis, indeed, is in some degree fixed to the diaphragm and spine, but the heart in its contraction always moves upon its basis as upon a centre; its ventricles, and especially its apex, are free; the point rises and curves so as to strike against the ribs; and the dilatation of the heart is such (together with the posture and relation of its several parts), that during the dilatation the heart turns upon its axis one way; the contraction of the heart reverses this, and makes it turn the other way, so that it seems to work perpetually with the turning motions of a screw. All this is most striking, while we are looking upon the motion of the heart in a living creature.

The posture of the human heart is very singular, and will illustrate this turning motion extremely well; for in the human heart the posture is so distorted, that no one part has that relation to another which we should beforehand expect. In the general system, the human heart is placed nearly in the centre, but not for those reasons which Dionis has assigned; it is not in order that by being in the centre it may feel less the difficulty of driving the blood to any particular

limb

limb or part of the body; it is the place of the lungs that regulates the posture of the heart; and wherever they are, it is. Except the Oyster, I hardly know of any creature in which the heart lies expressly in the centre of the body. In Frogs, Toads, Newts, and Snakes, the lungs are not moved by any diaphragm; they are filled only by the working of the jaws, the lungs then begin under the jaws, and the heart is lodged at the root of the jaws, leaving, as in a Newt or Cameleon, Crocodile, Adder, Serpent, &c. the whole length of their trailing body behind. In a fish, the gills serve the creature for lungs; the gills are lodged under the jaws, and the heart is placed betwixt them. In insects, as in the common Caterpillar (the aurelia of our common Butterfly), the air enters by many pores on its sides; and accordingly its heart is not a small round bag, but may be easily seen running all down its back, working like a long aorta, but having regular pulsations, denoting it to be the heart; and this you easily see through the insect's skin, for it is more transparent along the back where the heart is.

The breast in man is divided into two cavities by a membrane named the MEDIASTINUM. This membrane passes directly across the breast from the sternum before, till it fixes itself into the spine behind. It is on the left side of this membrane, in the left cavity of the breast, that the heart is placed, lying out flat upon the diaphragm as upon a floor, by which it is supported *; and that surface (*a*)—which lies thus upon the

* The true position of the heart is what is represented in N° 16. and 17; where N° 16. shows the heart set upright, as I have hitherto

the diaphragm, is perfectly flat, while the upper surface (*b*)—or what we usually call the fore-part of the heart, is remarkably round. The whole heart lies out flat upon the diaphragm; its basis (*c*)—where the auricles are, is turned towards the spine and towards the right side; the apex (*d*)—or acute point, is turned forwards, and a little obliquely towards the left side, where it strikes the ribs; the vena cava (*e*)—enters in such a manner through a tendinous ring of the diaphragm *, that it ties down the right auricle to that floor (as I may term it) of the thorax; the aorta (*f*) does not rise in that towering fashion in which it is seen when we take a dried-up heart, which naturally we hold by its apex, instead of laying it out flat upon the palm of our hand; nor in that perpendicular direction in which hitherto, for the sake of distinctness, I have represented it in these plans; but the aorta goes out from its ventricle towards the right side of the thorax; it then turns in form of an arch, not directly upwards, but rather backwards towards the spine; then it makes a third twist to turn downwards; where it turns downwards it hooks round the pulmonic artery (*g*),—just as we hook the fore-fingers of our two hands within one another. The right heart (*hh*)—stands so before the other, that we see chiefly the right

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hitherto represented it in all my plans, while N° 17. represents its inclined position lying almost horizontally upon the floor of the diaphragm.

* Let it be observed, that (*e*) in this drawing marks the point where the lower cava was tied close upon the diaphragm, to prevent the injection going down into the liver.

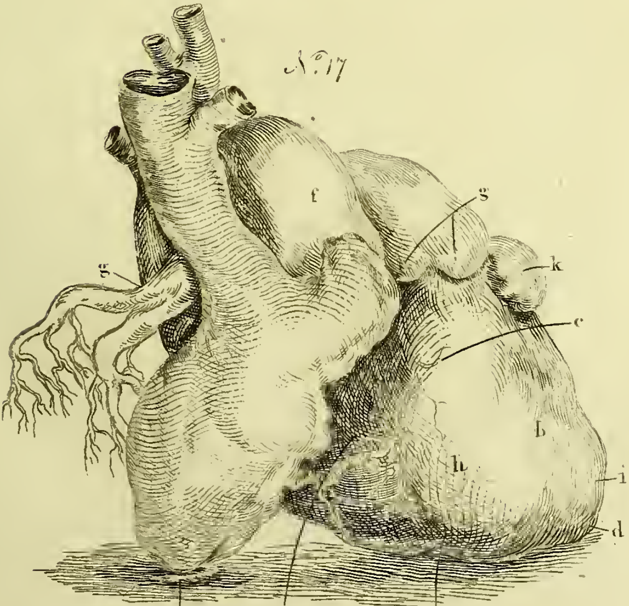
auricle

# Sketches

## demonstrating the true position of the Heart.

No. 16


No. 17




A. Bell Sc

auricle and ventricle before, so that it might be named the anterior heart; the pulmonic artery (*g*)—covers the root of the aorta; the left ventricle (*i*),—from which the aorta rises, shows little more than its point at the apex of the heart; the left auricle (*k*)—is seen only in its very tip or extremity, where it lies just behind the pulmonic artery; and the aorta (*f*)—arises from the very centre of the heart. From this view any man may understand these vessels by other marks than the mere colours of an injection; and he will also easily understand why the heart twists so in its actions, and how it comes to pass that its posture is difficult for us to conceive, no one part having that relation to any other part which we should beforehand suppose.

### Of the Pericardium.

But the PERICARDIUM, purse, or capsule, in which the heart is contained, affects and regulates its posture, and makes the last important point concerning the anatomy of the heart. It is a bag of considerable size and great strength, which seems to us to go very loosely round the heart, because when we open the pericardium the heart is quite empty and relaxed; but I believe it to surround the heart so closely as to support it in its palpitations, and more violent and irregular actions; for when we inject the heart, its pericardium remaining entire, that bag is filled so full that we can hardly lay it open with a probe and lancet with ut wounding the heart; and still further, when we open the pericardium before we inj ec the heart, the heart receives much more injection, swells to an unnatural bulk for the thorax that it is contained in,

 and

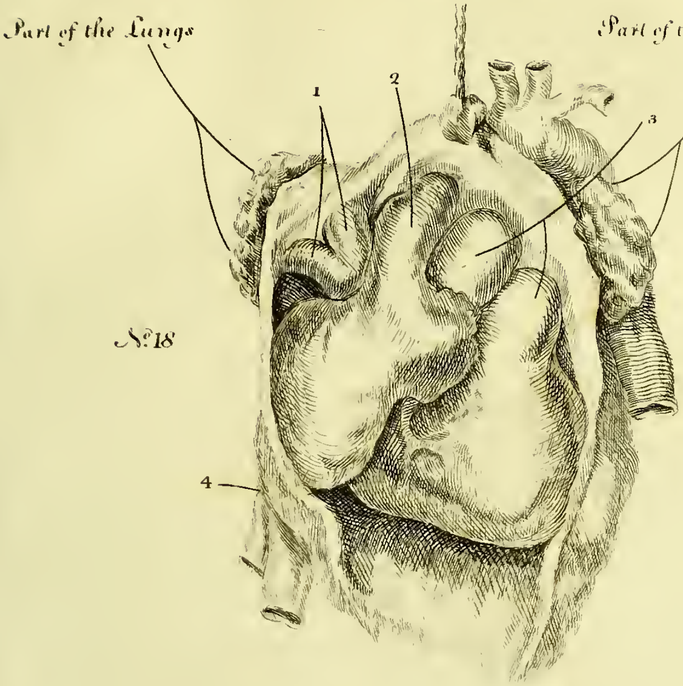
and loses its right shape. The pericardium is formed like the pleura and mediastinum, of the cellular substance; it is rough and irregular without, and fleecy with the threads of cellular substance, by which it is connected with all the surrounding parts; within it is smooth, white, tendinous, and glistening, and exceedingly strong. As the heart lies upon the floor of the diaphragm, the pericardium, which lies under the heart, is connected with the diaphragm a little to the left of its tendinous centre, and so very strongly that they are absolutely inseparable. The pericardium surrounds the whole heart, but it is loose every where except at the root of the heart, where it is connected with the great vessels: For the pericardium is not fixed into the heart itself, but rises a considerable way upon the great vessels, gives them an outward coat, and surrounds each vessel with a sort of ring, as may be seen in the plan*. For, 1st, It surrounds the pulmonic veins where they are entering the heart; there the pericardium is short: 2ndly, It mounts higher upon the vena cava than upon any other vessel; the cava of course is longer within the pericardium, and it also is surrounded with a sort of ring: 3dly, It then passes round the aorta and pulmonic artery, surrounding these in one greater loop: 4thly, The cava inferior is the vessel which is the shortest within the pericardium: for the heart inclines towards the horizontal direction; it lies in a manner flat upon the upper surface of the diaphragm, while the lower surface of the diaphragm adheres to the upper surface of the liver. Thus it happens that the liver and the right auricle of the heart are almost

* Vide Plan, N° 18.

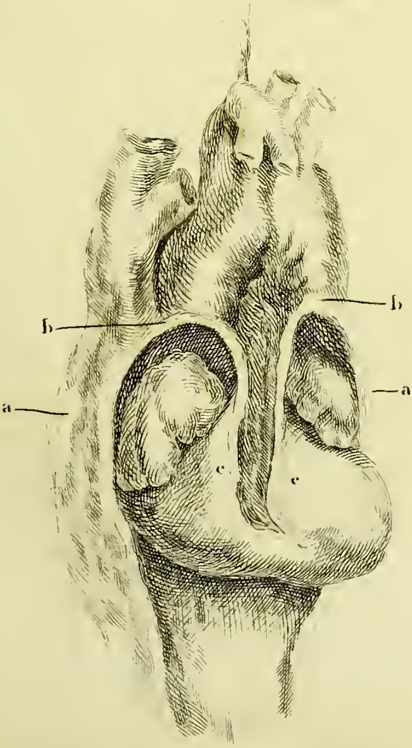
in

# Sketches
of the Pericardium of which No. 18 is a true drawing No. 19 a Plan shewing its inflexion over the Heart

No. 18




No. 19



in contact, the diaphragm only intervening; thence the lower cava which passes from the liver into the right auricle of the heart cannot have any length. While the pericardium thus passes round the great vessels, it must leave tucks and corners; and these have been named the CORNUA or horns of the pericardium.

But there is another peculiarity in the form of the pericardium, which I have explained in this second plan*; viz. that the pericardium constitutes also the immediate coat of the heart; for the pericardium having gone up beyond the basis of the heart so as to surround the great vessels, it descends again along the same vessels, and from the vessel goes over the heart itself. I have marked the manner of this more delicate inflection of the pericardium at *(aa)*—where the pericardium is loose; at *(bb)*,—the angle where it is reflected; and at *(cc)*,—where it forms the outer coat of the heart. The pericardium where it forms this outer coat becomes extremely thin and delicate, almost cuticular, but strong: under this coat there is much cellular substance; the coronary arteries pass along in this cellular substance, the muscular fibres are bound together by it, and under it the fat is gathered sometimes in a wonderful degree, so as to leave very little to be seen of the dark or muscular colour of the heart.

The pericardium then is a dense and very strong membrane, which I would compare with the capsule of any great joint, both in office and in form: for it is rough and cellular without, shining and tendinous within; bedewed with a sort of halitus like the great joints, delicate and almost a cobweb-like membrane

* N°. 19.

in the child, but increasing in thickness by the continual frictions of the heart, just as a capsular ligament does by the working of its joint; and its uses are to keep the heart easy and lubricated by that exhalation which proceeds from its exhalent arteries (and not from any glands), and which can be imitated so easily by injecting tepid water into its arteries, to suspend the heart in some degree by its connections with other parts, especially by its connections with the mediastinum and diaphragm; and to limit the distentions of the heart, and check its too violent actions, just as we see it prevent too much of our injections from entering the heart. How strong the pericardium is, and how capable of supporting the action of the heart, even after the most terrible accidents, we know from this; that the heart or coronary arteries have actually burst, but with a hole so small as not to occasion immediate loss of life; then the pericardium receiving the blood which came from the rupture, has dilated in such a manner as to receive nine or ten pounds of blood, but has yielded so slowly as to support the heart in some kind of action, and so preserved life for two or three days.

If I have not mentioned any fluid under the direct name of AQUA PERICARDII, or the water of the pericardium, it is because I consider the accident of water being found as belonging not to the healthy structure but to disease. Yet this same water occupied the attention of the older authors in a most ludicrous degree. Hippocrates believed that this water of the pericardium came chiefly from the drink we swallow, which found some way or other (as it passed by the pericardium) to insinuate itself into this bag:

Some

Some after him said, it was the fat of the heart melted down by incessant motion and the heat of the heart; some said it was from humours exuding through the heart itself, and retained by the density of the pericardium that this water came; and it is but a few years since this clear and distinct account of it was given, viz. "that it proceeds from the aqueous excrementitious humour of the third concoction." The same "sad and learned men*, viri graves et docti," declare to us, that the uses of the aqua pericardii are to cool the heart, for it is the very hottest thing in the body; or by its acrimony to irritate the heart, and support its motions; or to make the heart by swimming in it seem lighter. By this it is pretty obvious what absurd notions they had of the quantity of water that may be found in the heart. But of all the outrages against common sense and common decorum, the most singular was the dispute maintained among them, whether it was or was not the water of the pericardium which rushed out when our Saviour's side was pierced with the spear? The celebrated Bardius, in a learned letter to Bartholine, shows how it was the water of the pericardium that flowed out; but Bartholine, in his replication thereunto, demonstrates, that it must have been the water of the pleura alone. This abominable and ludicrous question, I say, they bandied about like boys rather than men: Bartholinus, Arius Montanus, Bertinus Nicelius, Fardovius, Laurenbergius, Chiprianus, with numberless other Doctors and

* They are thus denominated in all the charters of the College of Physicians from the time of Henry VIII. downwards.

 Saints,

Saints, were all busy in the dispute; for which they must have been burnt, every soul of them, at the stake, had they done this in ridicule; but they proceeded in this matter with the most serious intentions in the world, and with the utmost gravity *. The whole truth concerning water in the pericardium is, that you find water there whenever at any time you find it in any of the other cavities of the body. If a person have laboured under a continued weakness, or have been long diseased, if a person have lain long on his death-bed, if the body have been long kept after death, there is both a condensation of the natural halitus in all the parts of the body, and an exudation of thin lymph from every vessel; there is water found in every cavity, from the ventricles of the brain to the cavity of the ankle joint, and so in the pericardium among the rest. But if you open any living animal as a Dog, or if you open suddenly the body of a suicide, or a criminal who has been just hanged, not a drop of

* The shocking indecencies of their reasonings on this subject I will not condescend to draw out from the obscurity of that barbarous idiom in which was delivered: "Sed non cogar huc me conferre. Fateor enim nativam Christi temperiem nihil pravorum humorum produxisse, quia perfectissima; at a causis externis, vigiliis, cruciatibus, itineribus, vulneribus et mille tormentis quid non præter consuetam naturæ divinæ perfectionem productum credimus? Ad hæc sano sensu id accipiendum, nihil pravorum humorum in corpore Christi generatum." *Bartholini Epistolæ*, p. 299.—"Idque de Salvatore innoxie dixeris, quem scimus manducasse, bibisse, dormivisse, ambulasse et quid non egisse, ut se hominum cunctis actionibus, quæ secundum naturam sunt, submitteret: sputum emisit, quum luto misceret ad curandum cœcum, et sudavit ingruente martyrio, et sine dubio non parum seri in thorace collegit, quod, aperto post mortem latere, emanavit." *Bartholini Epistolæ*, p. 300.

water will be found in the pericardium. When such fluid is to be found, it is of the same nature with the dropsical fluids of other cavities: in the child, and in young people, it is reddish, especially if the pericardium be inflamed; in older people it is pellucid, or of a light straw colour; in old age and in the larger animals it is thicker, and more directly resembles the liquor of a joint.

Thus does the pericardium contribute in some degree to settle the posture of the heart; but still the heart is almost entirely loose and free. It is fixed by nothing but its great vessels as they run up towards the neck, or are connected with the spine; but how slight this hold is, how much the heart must be moved and these vessels endangered, by shocks and falls, it is awful to think. The pericardium is no doubt some restraint: its connections with the diaphragm and with the mediastinum make it a provision, in some degree, against any violent shock; its internal lubricity is, at the same time, a means of making the heart's motions more free: yet the heart rolls about in the thorax, we turn to our left side in bed, and it beats there; we turn over to our right side, and the heart falls back into the chest, so that its pulse is nowhere to be perceived; we incline to our left side again, and it beats quick and strong. The heart is raised by a full stomach, and is pushed upwards in dropsy; and during pregnancy its posture is remarkably changed; it is suddenly depressed again when the child is delivered, or the waters of a dropsy drawn off. It is shaken by coughing, laughing, sneezing, and every violent ef-

fort of the thorax. By matter collected within the thorax it may be displaced to any degree. Dr. Farquharson cured a fine boy, about eight years old, of a great collection of matter in the chest, whose heart was so displaced by a vast quantity (no less than four pounds) of pus, that it beat strongly on the right side of the breast while his disease continued, and as soon as the pus was evacuated, the beating of the heart returned naturally to the left side. Who could have believed that, without material injury, the heart could be so long and so violently displaced? Felix Platerus tells us a thing not so easily believed, that a young boy, the son of a printer, having practised too much that trick which boys have of going upon their hands with their head to the ground, began to feel terrible palpitations in the left breast; these gradually increased till he fell into a dropsy from weakness, and died; and upon dissecting his body, the situation of his heart was found to have been remarkably changed by this irregular posture. Now we are not to argue that such change of posture of the heart could not happen merely from this cause, because professed tumblers have not these diseases of the heart; it were as silly to argue thus against the authority of Platerus, as to say that every post-boy has not aneurisms of the ham, or that every chimney-sweep has not a cancer of the scrotum.

We may now close this chapter on the mechanism of the heart, in which all the parts have been successively explained. We know how the heart is suspended by the mediastinum and by its great vessels; how it

it is lubricated, supported and regulated in its motions, by the pericardium; its nerves, which remain to be explained at a fitter time, are extremely small, while its vis insita, or irritability, is great beyond that of all the other parts. We can easily follow the circle of the blood, which, as it arrives from all the extremities irritates the auricle, is driven down into the ventricle, is forced thence into the pulmonic artery, pervades the lungs, and then comes round to the left side of the heart, or to that heart which supplies the body; and there begins a new circulation, called the greater circulation, viz. of the body, as the other is called the lesser circulation of the lungs. Thus we recognise distinctly the functions of the double heart, with all its mechanism; the stronger heart to serve the body, the weaker heart to serve the lungs; and we see in the plainest manner two distinct functions performed by one compound heart: the right heart circulates the blood in the lungs, where it is purified and renewed; the left delivers out a quantity of blood, not such as to fill all the vessels, nor such as to move onwards by this single stroke of the heart to the very extremities of the body, but such merely as to give a sense of fulness and tension to the vessels: the force is merely such as to excite and support that action which the arteries every where perform in the various organs of the body, each artery for its appropriated purposes, and each in its peculiar degree.

By understanding thus the true mechanism and uses of the heart, we can conceive how the ancients were led into strange mistakes, by very simple and natural appearances. We understand why Galen called the right

right auricle the "ultimum moriens," or the part which died last; for, upon opening the body soon after death, he found the right auricle filled with blood, and still palpitating with the remains of life, when all the other parts seemed absolutely dead; and if the blood always accumulates in the right side of the heart before death, it is plain that the stimulus of that blood will preserve the remains of life in the right side, after all appearance of life on the left side is gone. But the cause of this accumulation of blood in the right side is very ill explained by Haller, though it seems to have employed his thoughts during half his life. He says that in our last moments we breathe with difficulty; the lungs at last collapse, and cease to act; and when they are collapsed, no blood can pass through them, but must accumulate in the right side of the heart. That there is really no such collapse of the lungs, I propose hereafter to show; but, in the meanwhile, this is the true reason, viz. that when the ventricles of the heart cease to act, and the beating of the heart subsides, the two auricles lie equally quiet, but in very different conditions; the right auricle has behind it all the blood of the body pouring in from all parts during the last struggles; but the left auricle has behind it nothing but the empty veins of the lungs; nothing can fill it but what fills the vessels of the lungs; or, in other terms, nothing, can fill the left auricle but the stroke of the heart itself; but instead of acting, the heart falls into a quiescent state, the left auricle remains empty, while the blood oozes into the right auricle from all the extremities of the body till it fills it up.

Nothing

Nothing is more agreeable than to find such phenomena described faithfully long before the reason of them is understood. In the Parisian dissections I find the following description: "When the breast of a living Dog is opened by taking away the sternum, with the cartilaginous appendices of the ribs, the lungs are observed suddenly to sink, and afterwards the circulation of the blood and the motion of the heart to cease. In a little time after that the right ventricle of the heart and the vena cava are swelled, as if they were ready to burst."* This was what deceived the ancients, and was the cause of all their mistakes. When they found the right ventricle thus full of blood, they conceived that it alone conveyed the blood; they found the left ventricle empty, and believed that it contained nothing but vital spirits and air: and so far were they from having any notions of a circulation, that they thought the air and vital spirits went continually forwards in the arteries; that the gross blood which was prepared in the liver came up to the heart to be perfected, and went continually forwards in the veins, or, if they provided any way of return for these two fluids, it was by supposing that the blood and spirits moved forwards during the day-time, and backwards in the same vessels during the night.

These things next explain to us why they called the right ventricle VENTRÍCULUS SANGUINEUS: they found it full of blood, and thought its walls were thinner, because it had only to contain the very grossest parts of the blood; and why they called the left ven-

* Page 261.

tricle VENTRICULUS SPIRITUOSUS and NOBILIS, because they saw it empty, and concluded that it contained the animal spirits and aerial parts of the blood, and its walls were thicker, they said, to contain these subtile spirits. They explain to us their names of ARTERIA VENOSA and VENA ARTERIOSA; for they would have veins only on the right side of the heart, and arteries only on the left; and although they saw plainly that the pulmonic artery was an artery, they called it Arteria Venosa; and although, on the left side again, they saw plainly that the pulmonic vein was merely a vein, they would still cheat themselves with a name, and call it Vena Arteriosa: the veins they said, were quiet, because they contained nothing but mere blood; the arteries leaped, they said, because they were full of the animal spirits and vital air.

The very name and distinction of arteries which we now use, arise from this foolish doctrine about air and animal spirits. To the oldest physicians there was no vessel known by the name of artery, except the ASPERA ARTERIA; and it was named Artery because it contained air; so that Hippocrates, when, he speaks of the carotids, never names them arteries, but calls them the Leaping Veins of the neck. But when Eristratus had established his doctrine about the vessels which go out from the heart, carrying vital spirits and air, the name of artery was transferred to them; and then it was that the ancients began to call the vessels going out from the left side of the heart arteries, naming the aorta the ARTERIA MAGNA and the pulmonic vein the ARTERIA VENOSA.

When

When a vein was cut, they saw nothing but gross blood, and of a darker colour; but when an artery was cut, they observed that the blood was red; that it was full of air bubbles; that it spurted out, and was full of animal spirits; and thus it became easy for them to show how safe it was to open a vein where nothing was lost but gross blood, how terribly dangerous it was to open an artery which was beating with the spirit of life; and this they considered as such an awful difference, that when arteriotomy in the temple was first proposed, they pronounced it murderous, and on this reasoning it was absolutely forsaken for many ages.

But the oldest of our modern physicians soon found a necessity of mixing this blood and animal spirits together, and for a long while could hit on no convenient way by which this mixture might be effected: as a last shift, they made the blood exude through the septum of the heart; and then the current doctrine was, that of the blood which came from the liver, one half went into the pulmonic artery to nourish the lungs; the other half exuded through the septum of the heart to mix with the animal spirits. Riolanus was the bitter enemy of Harvey and of his noble doctrine; and this is the miserable and confused notion, not to call it a doctrine, which he trumpeted through Europe in letters and pamphlets. To make good this miserable hypothesis, Riolanus, Gassendus, and many others, saw the necessity of having side passages through the septum of the heart. I really believe from their mean equivocating manner of talking about these passages, that

that they had never believed them themselves*. "The chyme," says Bartholine, "and the thinner blood, passes through the septum of the heart, when the heart is in systole and the pores and passages are enlarged." Thus did the celebrated Bartholine believe the septum perforated. Wallæus, and Marchetti, and Mollinettus, and Monichen, believed it, and Mr. Broadbecquius of Tubingen proved it †. But I believe most potently with Haller, that whenever they wanted to show those perforations, they managed their probes so as to make passages as wide and as frequent as the occasion required: "Solebant foramina parare adigendo stylos argenteos in resistens septum," says Haller; and this is a full and true account of all the authors who have described side passages through the septum of the heart: they needed them, and they made them.

Amidst all this ignorance, we cannot wonder that a thousand childish imaginations prevailed, nor that the qualities of the mind were deduced from the physical properties of the heart. We have heard the vulgar, for example, speak of the bone of the heart. And from whom did this arise? From Aristotle! who explains to us, that there is at the root of the heart a bone which serves for its basis; and not a physician has written upon the heart since his time, who has not spoken more or less mysteriously about this bone:

* That I may not seem to speak too harshly of this knot of conspirators against Harvey, I will quote what Boerhaave says of Riolanus, who was at the head of them: "Non ipse callidus cavillationum artifex Riolanus," &c.

† Experimento perforatum ostendit Broadbecquius Tubingæ.

while

while in truth the whole story means nothing more than this, that where the basis of the arteries are fixed into the hard ring or basis of the heart, the place is extremely firm, almost cartilaginous, especially in old age, when often the roots of the arteries are ossified, or converted into what anatomists have chosen to call bone.

Often also we have heard the vulgar talk, not figuratively, but in the plain sense of the words, of a little or big heart, as synonymous with a timorous or courageous heart. But whenever we hear mistakes of this kind among the vulgar, we may be assured they have some time or other come from high authority. Bartholine was so much convinced that a small heart begot courage, and a great one irresolution and fear, that he is thoroughly surprised when he finds the contrary; "Cor vastus fuit homo, tamen audax fuerat, ut cicatrices in capite frequentes et rimæ in cranio testabantur." But if Bartholine be right, Kirkringius is quite wrong, and has mistaken the doctrine; for he says, "An magnanima fuerit hæc magni cordis fœmina, nescio," &c. "I do not know whether this woman's courage was as big as her heart; but this I do know, that she was a famous toper. Whether this drinking dilates the heart, and makes your staunch drinkers such famous fighters, I cannot pretend to decide." We have heard the vulgar talk also of a hairy heart, as familiarly as of a hairy man, being the mark of high courage and strength; but what shall we think of it, when we find that this report is to be deduced fairly from Pliny, through the most celebrated names among our old physicians? He it was who began

gan with telling how the Messenians, that unhappy people who lived for so many ages the slaves or helots of Greece, lost their great general Aristomenes. But how great he was, never, according to Pliny, came to be known till after his death; for the Lacedemonians having catched him three times, resolved at last to open his breast; and there, as a proof of his most invincible courage and daring, they found his heart filled with hair. This from Pliny were nothing, if such dissections had not been made since then a hundred times. "There was a robber (says Benivinius), one Jacobus, who having been taken down from the gibbet apparently dead, but really having in him the remains of life, was laid carefully, recovered, was perfectly restored, betook himself to his old ways again; and so in the natural course of things came round to his old mark the gallows, and was this time very thoroughly hanged. Wondering (says Benivinius) at the perfect wickedness of this man, I longed very anxiously to dissect the body, and I actually found the heart, not covered, but (refertum pilis) crammed with hair."

But there is, in fact, no end of wonders and wonderful dissections among these robbers of his. His next subject was not a bold robber, but a poor sneaking thief (de corde furis cujusdam); there was no hair to be expected in his heart; but as he was a thief only, it was consistent with this doctrine that he should be first very heartless; secondly, have very little brain; thirdly, that he should have very inordinate appetites and desires. Now there was first a great two-legged vein carrying the atrabilis, the source

source, no doubt, of all his inordinate cravings, directly into the stomach. Secondly, there was a great abscess full of pus wasting the left side of his heart; and, thirdly and lastly, the back part of the head, (which all the anatomists of that time knew very well was the seat of memory) was in him so small that it could hardly contain a spoonful of that kind of brain; and this want was the reason (having so little memory) that he was so persevering a thief; for let you whip him, banish him, clap him in the stocks, he forgot it straightway, and was back at his old tricks again, like a dog to his vomit*."

But these are now almost forgotten, though perhaps the history of the absurdities of the human genius should no more be neglected than of its beauties. Is it not delightful to feel, that after floating in this ocean of conjecture, after all these disorderly and wild dreams, we are come to have an idea of the heart, simple and beautiful; of a heart containing within itself two functions; first, the office of renewing the blood; secondly, the office of animating the arteries, and by them preserving in life and action the whole system of the body? These are the two offices which I shall now proceed to explain.

* "Non videntur silentio esse prætereunda, quæ nuper in inciso Jacobi cujusdam furis insignis cadavere annotavimus: bifurcatam scilicet venam quæ a liene ad ventriculum atram defert bilem, tum et abscessum in sinistro cordis ventre pituita redundantem: postremo et posteriorem ejus capitis partem, ubi memoriæ sedes est, adeo brevem, at tantillam cerebri portiunculam contineret. Quam ob causam, cum priorum scelerum et eorum quæ pro his sæpe passus fuerat, tormenta scilicet, exilia et car-

## CHAP. II.

### ON THE APPEARANCE AND PROPERTIES OF THE BLOOD, ON THE CHEMISTRY OF OUR FLUIDS, AND ON THE INFLUENCE WHICH AIR HAS UPON THEM.

By the simplest methods the blood can be resolved into various parts, but chiefly into these three; the red globules, which give colour to the blood; the gluten, which gives consistency and nutritious qualities to the blood; and the serum, which dilutes, mixes, and suspends the whole.

Though the serum and gluten did not pass entirely unnoticed, the red globules were the part of the blood which first excited the attention of physicians, and seemed to promise a rich harvest of discoveries; a promise which too surely never was fulfilled. The red particles have always appeared important, because they seem to give the colour, the useful qualities, and the whole character to the blood. It is by the rolling of the red particles only that we see the circulation in the microscope; it is red blood only that we ever name as blood; and the colour of the red blood changes in health and disease. But when physicians studied this

ceres minime recordaretur, toties ad vomitum tanquam canis impudens reversus est, ut in laqueum tandem inciderit, vitæque ac furti finem fecerit."—Vid. *Benevinius.*

part

part alone, when they gave it the mark of chief importance, annexed to it alone the name of blood, they little thought how far they over rated its importance, how far the red particles are from nourishing the system, from being essential to the blood, from being universal in all creatures. They had not considered what myriads of animals, great as well as small, want the red particles, and (if these red particles are to be the characteristic) want blood; while philosophers of less contracted notions have continued to call that fluid, blood, which fills the vessels of plants.

The Harveian doctrine had no sooner produced a revolution in the general doctrines of physiology, or physicians begun to think of the heart and its circulation, of the great arteries, and extreme vessels, of the difference betwixt arteries and veins, and of the ways in which the fluids move through the smaller tubes, (for they saw them moving by their microscopes); no sooner did all these phenomena and new wonders present themselves to their imaginations, than they thought also of curious ways by which these motions and secretions might be explained. They then began to estimate the calibres of the arteries, to calculate with great affectation of care the shape, the size, the composition, as they chose to call it, of the particles of the blood; chimeras and fancies sprung up innumerable; and it happened unfortunately that for a long while physicians studied nothing but angles, and logarithms, and algebraical equations; they reasoned according to those sciences only which have no connection with the physiology of the animal body; they calculated the force, the thickness, the dimensions of the

heart; the diameter, and the strength of walls, and the direction of the aorta; their experiments consisted in fixing clumsy tubes into the arteries, or in calculating the whole quantity of blood by bleeding an animal to death; they applied nothing but the laws of hydraulics, *i. e.* of fluids rising and falling in rigid tubes, to explain the active arteries of a living body: in short, in explaining the living body they forgot that it was alive. But now the age of infallible proofs and demonstrations has passed over, and the works of Keill, Pitcairn, Borelli, are quite neglected.

This disordered and miserable state of science, which continued for a century nearly, arose from those red particles of the blood engrossing too much attention, and from their being allowed an importance which does not belong to them; although one must still acknowledge that they are very surprising, because they are very unaccountable, at least I do not know that any natural or likely use for them has been yet assigned.

Leeuwenhoek, looking through his glasses, saw that this which gave the red colour was the most permanent characteristic part of the blood: he saw that this part consisted of red particles floating in the serum; he found, or pretended to find, that they were of the same size in a Man as in a fœtus; in a Chick as in a Hen; in a Whale or Elephant, he found them the same as in a Mouse or Minnow; merely because it was convenient for him to find it so.

But poring still longer over these particles, he perceived that the great globules were so far imperfect as often to break in pieces, and roll about in the serum in separate parts; and he always found that there were

were six less parts composing the greater globule of the blood. By looking more and more, he pretended to observe, that these smaller parts into which the red globules broke down still preserved their form; that these were the particles of the serous part of the blood; and that the great or red particles frequently broke down into serous particles, and these again as frequently united and composed afresh a red globule. He pretended to find, that exactly six smaller globules went to make up one great one; and he called the red and serous globules the globules of the first and second order.

By this notion of orders it was plain that he intended to plunge deeper into this hypothesis, and to have at least a third and fourth order; besides, these orders and particles were at his call, he might do as he pleased; and he was almost the only person possessed of glasses which could enable the physiologist to see and tell about them. He pored till he believed, or at least made others believe, that he saw globules of a third order, six times smaller than the serous globules, and of course thirty-six times smaller than the red globules. And thus he had lymphatic particles, six of which made up one serous particle; and serous particles, six of which made one red globule.

To the geometrical physiologists of that day all this instruction concerning the structure of the blood was most delightful; it corresponded very notably with their calculations about regularly descending series of vessels; and a most curious method did they find out for settling this law of the branching of arteries. They took the plates of Eustachius, measured with

compasses the arteries and veins, estimated the angles at which each branch goes off, compared the several branches with the parent trunk; and from such calculations they settled the general law as heartily and freely, as if, instead of the most extravagant plates in all anatomy, they had been measuring actually the human body itself. Thus they had set up their doctrine of angles, branches, anastomoses, trunks, and extreme vessels: they had found that there was a regular series of descending arteries; they had a tube now suited to every descending particle that Leeuwenhoek could invent; and when a particle had got into a wrong vessel, it could go back till it found a tube that suited it; or if driven into a wrong bore, it could break itself down into serous or lymphatic particles. But when many particles did stick hard in the strait places, then there was an error loci; then the big particles were out of their peculiar vessels, and then the part began to be red: thence came inflammations, fevers, deeper obstructions; and from such causes, or from the breaking down of the blood and humours, came every disease that could be named.

So very greatly were they delighted with the discovery, that Dr. Martin, who had measured the vessels, as I have just told, and had dreamt over this the longest and soundest of them all, speaks of it in these rapturous terms. "But we are moreover certain from the observations of that most accurate and curious observer of the minima naturæ, that there are innumerable vessels of such a smallness that none of these globules could pass; so that it is necessary to suppose inferior classes of globules of the fourth, fifth, sixth, and other

other orders.—Whence by analogy we are to conceive globules of the third order made up of six globules of the fourth order, and these of six of the fifth order, and so on ad infinitum through various degrees, the number of which we are not to take upon us to determine." This is a pleasant addition of Dr. Martin's; and makes it a most manageable system of most dilatable materials, stretching so as to suit all occasions. This rider or codicil to the doctrine made it easy for every particle to pass every vessel; but, alas! it leaves no room for that old catchword of the system, the error loci, nor any provision for making diseases.

How all the physicians in Europe could digest this absurdity, of yellow particles, by aggregation and arrangements in sixes and sixes, becoming red, it is not easy to conceive; nor is it easy to conceive how men, whose education in mathematics and algebra should have taught them to think accurately and reason closely, could believe that globules should break down into six particles each, and that these particles, being themselves particles of serum, should yet be distinctly seen floating in the serum. How could these geometrical physicians possibly believe, that these particles, from large to small, should descend, not gradually and imperceptibly, but by sixes and sixes, one after another like steps of stairs? In all his mathematics, I do not believe that Martin could find any contrivance fit to help him out of these difficulties. Martin observes, in his own way of geometry, and proceeds to prove it by most laborious schemes, "that just six small sphericles should go to make up one larger globule, if you

were to choose the most convenient and firmest way of constructing it;" and then he wonders at Leeuwenhoek finding it exactly so. But if Leeuwenhoek knew this as well as Dr. Martin, I cannot for my heart think it any wonder that Leeuwenhoek chose "the most convenient and firmest way of constructing a red globule, viz. out of six smaller ones." Seeing that he had the affair entirely in his own hands, "what a beautiful HARMONY and REGULARITY do we perceive, says Martin, in the mass of blood? Magnum certe opus oculis video." In plain truth, they desired but a little of this harmony, a little consistency in their doctrine, and all was well.

But the mistakes concerning the formation or organizing of this blood are worse than these; for they came from men truly learned, and diligent in anatomy, led on by too strong a desire of finding out the uses of several parts of the human body, as of the Spleen and Thymus, parts hitherto unexplained. Mr. Hewson supposed that the lymphatic glands, which seem at first to be mere convoluted vessels, but which microscopes shew as consisting of numerous cells, form in these cells the primordia of the red blood; for each red particle he supposes to consist of a central particle, which is solid and dark-coloured, surrounded by a vesicle which is transparent or white; and this dark or central part he supposes is formed in the lymphatic cells; for he finds a sort of round particles in the lymph, and often he finds the lymphatics full of red blood.

Next, he has supposed that in the child there is required a much greater supply of blood; for this pur-

pose

pose is the thymus appointed; viz. to assist the lymphatic glands in organizing blood. This gland lies in the upper part of the chest, is great in the child, has vanished in the adult, but while it exists, he finds it full of a milky juice or whitish mucus, fit to make central particles for the blood; and the lymphatics, as he supposes, are the excretories for this gland. He next conjectures, that this work, begun thus by the lymphatic glands, and thymus, is perfected by the spleen; that the lymphatics make central particles only, while the vesicular coverings are formed in the spleen; so that there only do the particles become perfect; and accordingly of these parts it is in the spleen alone that the red blood is found.

As the central particles are formed in the cells of the lymphatic glands, the vesicular parts are formed in the cells of the spleen, and the lymphatics unload these cells of the particles when completely formed: but there appears no other proof that they do this office than that there are cells in the spleen which may make vesicles; and that the lymphatics being tied, and the spleen squeezed, red globules are sometimes found in them.

Long poring over a wearisome subject, and an intense desire to finish that account of the blood which he had so successfully begun, are strong apologies for all these mistakes. No man will venture to deny, that the glands and lymphatic vessels probably accomplish some important changes upon all fluids which pass through them; but that they alone organize the blood is not to be conceived. Their containing round white particles, argues nothing; these exist in the chyle, and probably

probably in that condition pass into the blood. But if the fœtus requires a great supply of blood, and the thymus assists the lymphatic glands, how comes it, when both lymphatic glands and thymus are working in concert to prepare a great quantity of blood, that the spleen, which is to finish all these particles, and to make vesicles for them, is not in a child as big as its liver is?

That red globules are found in the lymphatics, and most especially in the lymphatics of the spleen, is a most ordinary occurrence, and quite intelligible. There are not found any where, not even in the spleen, imperfect globules advancing in their organization; on the contrary, those which we do find are full formed globules which have been forced out of the common line of the circulation; they are extravasated, and taken up by the absorbents before death; or they are squeezed into them by handling after death. If we want to have an example of the first, we have but to inflame a part and tie up its lymphatics, and then many red particles are found in them; the second we see every time we either look for, or prepare the lymphatics of the spleen, or of any other soft viscus; for by handling and squeezing, the blood passes through the small breaches occasioned by this violence into the lymphatics; if we allow the part to spoil, then air is generated, and, by handling it, air passes into the lymphatics in the same way.

But the spleen is essential to finish the work; it makes the vesicles, and has cells for the business; and yet this part, which has the most important of all offices, viz. that of organizing the general mass of blood, is every day cut out from Dogs and other animals,

mals, and they never feel the loss, nor decline in health. There is not the smallest doubt that the spleen has protruded at wounds, and been strangled, and so cut off. Every day we find it more or less diseased; sometimes it has swelled to thirty or forty pounds; sometimes it has been reduced to an extremely small size; sometimes it has been found like an empty bag.

In the fœtus, as in a Chick for example, red blood circulates in great profusion long before its lymphatics, spleen, or thymus, can be seen to exist; whereas, on the contrary, since the Chick is insulated, and has no red blood from the mother, the spleen should have been first coloured, and all the red blood of the system should have emanated from the spleen.

It is but a poor evasion to say, in answer to these objections, "some other part may perform this office of the spleen." What other parts will perform the office of the liver, if it be wanting? or of the kidney, or of the testicle, or of any other gland? or will the testicle secrete urine, or the kidney secrete bile? What gland, then, will be able to perform so peculiar an office as this of adding vesicles or coverings to the central parts of the blood.

After all this long dream about the vesicles and their central parts, the best physiologists of the present day seem to deny that they exist.

But one author has finished this career of useless speculation, by maintaining that the LIFE is in the BLOOD: and thus we have seen this simple and beautiful subject of the blood tortured through all kinds of imaginations, and running its fiery ordeal, first through mathematics,

mathematics, then through anatomy and all its glands, then through metaphysics; till at last we are come to talk with the most perfect ease and confidence about the most monstrous of all absurdities, the life of the blood.

"For in the blood is the life thereof," might be a useful doctrine among the Jews, if it moderated their desire for blood; and if among physicians this were to be the tendency of such a doctrine, it were very cruel and unnatural to disturb it: but, in serious earnest, it introduces into modern physiology nothing but a jargon of words, and perverts every idea that the mind of man can form of parts which excite and parts which act. Whimsical theories creep faster into physic than useful facts; and the business is fairly enough begun when surgeons, dissecting aneurisms of the carotid arteries, and who should be employed in recording how and from what causes they have arisen, or how such diseases affect the arterial coats, choose rather to inform us "that this state of the blood, or rather of the coagulable lymph, may arise from some connection or sympathy it may have with the diseased state of the artery." "By lightning (says a celebrated author), death is so instantaneously produced in the muscles, that they cannot be affected by the stimulus of death." Connections, and unknown sympathies, and living powers in fluids, and energies, and efforts, and intentions, and "sympathetic congelations in the blood," and "immediate sympathetic contiguous harmonies of cut parts," and the "diffused principle of life," and "the stimulus of death;" are words which physiology would gain by losing, and are

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the very cant belonging to the doctrine which I propose to refute.

It is not merely the doctrine of a living principle existing in the blood that is now to be spoken of, but a doctrine attributing the life of the solids to this living principle of the blood; so that it may be intitled "the new theory concerning the blood which is itself alive, which gives life to all the other parts, and which in the beginning forms all the parts out of itself in the mother's womb;" so that a fœtus is merely a speck of blood, and all the parts being formed from that speck of blood, the whole of physiology is abrogated henceforward, and totally annulled, except this theory itself. It is like the staff of Moses converted into a serpent, which ate up the serpents of all the magicians who had thrown down the staff before him; for if this theory were once established, there would remain nothing to be done in all the animal body but what was done by the blood; nothing to wonder at, nothing to guess about, nothing to study, but this vital and plastic power of the blood.

The author of this doctrine shows us two or three specks in an incubated egg; he tells us that they are dots of blood; he tells us that this blood forms the vessels in which this blood itself is to move; it forms the limbs of the Chick which these vessels are to serve; the bones, muscles, bowels, glands, the whole creature is formed out of it; and when the bird is delivered from the egg, the living principle of the blood still continues to support it. The blood heals its flesh or bones when they are broken; "the blood moves in the living solids, which it both forms and supports."

It

It is not easy to say on which of all his proofs Mr. Hunter chiefly relies for establishing a doctrine so important as this is; whether he considers it as a perfect proof of the vitality of the blood that it coagulates, or that this coagulum has moreover the power of becoming perfectly alive, and of forming new vessels within itself; or that blood seems to assist the union of contiguous parts; or that by taking away its blood a creature dies; or that a limb falls into immediate gangrene when its vessels and its supply of blood are cut off. But chiefly he seems to rely on coagulation as a proof of the vitality of the blood; for he considers the coagulation of the chyle as a proof that it also is alive; and he says, "contraction is the life of the solids; and if we can find any thing like it (by which he means coagulation), we shall call it the living principle of the blood."

But what harmony he can find betwixt the occasional, voluntary, regulated, contractions of the living solid, and this sudden, irretrievable, inorganic, coagulation of the blood, I cannot conceive. Does not jelly coagulate; and what is it but a part of the blood? Does not glue congeal, dissolve, and congeal again, yet what is it but an animal jelly? Does the blood itself ever congeal till it is out of the body, or extravasated in aneurismal sacs? When it is out of the body, it coagulates; when it coagulates, it is dead; coagulation is so far from resembling the contractions of the living body, that it is the marked character of dead animal matter, which you melt and coagulate again and again. Shall we then define life by saying, coagulation is the mark of the vital principle?

piple? If so, we give the mark of its death as the proof of its living power.

But in his awkward attempts to prove this point, the author has brought himself into great suspicion, and of course into great dishonour, by two experiments, in which he endeavours to show how this vital power, like the life of a perfect creature, is affected by cold first. In page 79, we are informed, that a fresh egg, in consequence of being alive, resists the cold, and is frozen with great difficulty; but being once frozen and thawed again, it loses its living principle and its power of resisting cold at once; it freezes now at the same temperature with other animal matter, showing no longer any power of generating heat, or resisting cold.

But we are told*, that the blood having a determined period for coagulating, you may, during that time, freeze the blood, and it will thaw again, and yet congeal at its proper time; and he tells us, that he had very cleverly frozen blood in the very time of its flowing from the vein, then thawed the cake, and still in due time it congealed. Now since the egg resists cold by its living principle, why did it die or lose that living principle when converted into ice? or rather, since the blood coagulates through its living principle, and by a living effort, how did it preserve its living principle after being frozen? This proves surely, either that the blood's coagulation has no relation to any living principle, and therefore is not affected by the cold; or that the egg has a living principle of a very different kind, which is absolutely

* Page 87.

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and totally extinguished by cold. I am sure, that had Mr. Hunter seen these two experiments brought face to face in this manner, he would have put one of them at least back quietly into the portfolio from which they both came. I have always observed, that your great tellers of experiments need to have good memories; and I am come to look on a suite of experiments as coolly as upon a set of neat plans and figures by which the author chooses to illustrate his hypothesis.

That this coagulum, being once formed, has the power of becoming more perfectly alive, and forming vessels within itself, it is not easy to conceive. Nothing indeed is more common than clots of blood, or depositions of the coagulable part, becoming highly vascular, by vessels shooting into them from surrounding parts; but this is of no value in Mr. Hunter's doctrine; this is not the fact which he means to speak of; this is much too natural and easy for him; and that his meaning may neither be misrepresented nor mistaken, I quote his words; "When new vessels are formed, they are not always elongations from the original ones, but vessels newly formed, which afterwards open a communication with the original." That a clot of mere blood should have in it a living principle, and should possess through that principle the power of forming within itself arteries and veins, a new and independent circulation; that it should have the privilege of knowing when it should exert itself thus, is really wonderful; that it should have some kind of intelligence; or consciousness, by which

which it could understand when it were within and when without the body; and whether in certain circumstances it were fit that such vessels should be formed! That clots should have been busied forming vessels within them for ages, and no body ever have seen the process going on! That Mr. Hunter, who has been looking out for vascular clots for thirty years, never should have seen this phænomenon, is all very surprising. Mr. Hunter falls into a deeper blunder in this business than in the affair of the frozen egg; he absolutely never saw a proper vascular clot. He informs us most deliberately in page 92, "that he thinks he has been able to inject what he suspected to be the beginning of a vascular formation in a coagulum, when it could not derive any vessels from the surrounding parts." From whence then did this clot derive its injection? this is a question which detects at once what Mr. Hunter was doing, and puts this experiment pretty much upon a footing with the frozen egg.

To say "that the blood, in some circumstances, unites living parts by a sort of contiguous sympathy as certainly as the yet recent branches of one tree unite it with another," is to put forth a syllogism, in which both major and minor propositions are untrue. First, it is not true, that it is the juices of the tree which unite the graff to the stock; it is the living fibres, and the living vessels of both; and unless both be alive, the process must fail, living juices would do no good. Secondly, though the juices did so unite or glue together the branches of a tree, that were no proof of the juices being alive; but only that good

juices, whether alive or not alive, were necessary to the process.

Any man who affirms that in surgical operations it is the blood, "that by a contiguous sympathy unites the parts," should have supported his assertion by this further argument, that without blood they will not unite. Prove to me only that fresh cut parts are not alive, and cannot naturally unite without the assistance of some foreign power, and then I will acknowledge willingly that they are altogether beholden to the intermediation of the blood, with its living principle, and sympathy of contiguity.

But it is very singular, that any person, even the least instructed in forms of reasoning, should have advanced this as any proof of living principle in the blood, "that mortification immediately follows where the circulation is cut off;" for this proves merely, that the blood is one of many stimuli, by which the system is supported, in so much, that each limb is affected just as the whole body would be; and whether you stop the blood, which is one stimulus, or take away its heat, which is the stimulus next in power to the blood, the limb will equally die.

To say that the life is in the blood, because the blood being taken away the limb dies, or because an animal may be bled till it dies; what is this but to jumble all distinction of cause and effect? The water no doubt, is the life of the mill, and the plough-horse is the very life of the plough; for the mill and the plough are dead the moment that the horse is gone or the water fails.

Lastly, we are told "that it is by the contiguous sympathy

sympathy of the blood and body both being alive," that they both work upon each other mutually: but is it not very strange for any physiologist to forget, that the blood is at least in part a foreign body, that it must be continually impregnated with air, that it is neither its original constitution, nor these presumed sympathies that make it vital blood, that it becomes vital blood only by exposure to air, and that if this foreign principle be not continually added, the solids are not wrought upon by the blood?

The natural difficulties of this doctrine are very great; for it seems to be against all the laws of nature that any fluid should be endowed with life. A fluid is a body whose particles often are not homogeneous, have no stable connection with each other, change their place by motion, change their nature by chemical attractions and new arrangements; a body which can have no perfect character, no permanent nature, no living powers connected with it. But the definition of a solid is the reverse of this: a solid among every kind of metals, earths, or fossils, is recognized by its peculiar form and arrangement of parts: and in the animal body, the arrangement of particles gives the permanent unchanging character of each part; and in the muscles, for example, or in the nerves, where feeling and irritability chiefly reside, the form and mechanism of the solid is in each most peculiar, and is always the same.

What is this blood that it should begin life and support it, and distribute it through all the system? Is it not a fluid which varies every hour, now richer, now poorer, now loaded with salts, now drowned in

serum, now much, now sparingly supplied with air, now darker coloured, now red, now fully supplied with chyle, and now starved of its usual supply? Is it not lost in astonishing quantities in hæmorrhagies, and drawn very freely from our veins upon the slightest disease? That such qualities are consistent with life in the blood, is what I cannot believe. But I can most easily imagine how the system, having by successive operations converted the food into chyle, the chyle into blood, and fashioned the nutritious part of the blood into various solids; these new solids may partake of the vitality of all the parts to which they are applied, and to which they have been assimilated by so peculiar and so slow a process.

The question is plainly this: Shall we follow the general laws of the system, such as physiology acknowledges? or shall we admit an absurd novelty without proof? Shall we allow of the simple accident of coagulation (an accident common to dead fluids) as a proof of life? or shall we forget those stupendous proofs of the irritability residing in the heart, muscles, and other forms of our living solids, and which is the source of all the various actions of the body? Shall we forget that polypi, worms, insects, the bloodless parts of fishes, the uncoloured parts of the human body, even plants almost inanimate, all partake of life, without having red blood in their system, or having it restricted to the central parts? All these have life and vitality, but where is their blood? In short, the question plainly resolves itself into this, Shall we have two living parts, fluid and solid; two agents acting on each other? or shall we follow the common law of the œconomy, call the

the one an exciting power, while the other receives that excitement, being alive only that it may feel and act according to the degree in which it is moved? Shall we have the blood communicating life to all the body? or the body only alive, and the blood, like various other excitements, acting upon it with those powers which it is continually acquiring, without acquiring along with them any share of life?

But Mr. Hunter, ill contented with his doctrine himself, he even who began with giving to the blood a vital principle, and calling it the former of new parts, and the substance whence the living solid derives its life, hatches a new doctrine out of the confusion of the first; takes from the blood all those high privileges in the system which he had so freely bestowed upon it, and gives them in full perpetuity to a new principle, a principium vitæ diffusæ, which he announces thus:

"I would consider that something similar to the substance of the brain is diffused through the body, and even contained in the blood; and between this (viz. the matter diffused in the blood) and the brain the communication is kept up by nerves." This matter he does not like to define, but he must name it; and having observed, as others have done, that a mouthful of nonsense sounds infinitely better in Latin than in our mother tongue, he calls it the "Materia vitæ diffusa."—Concerning this diffused principle of life he tells, us, that every part of an animal has its due proportion; it unites all the body into one; "it is as it were diffused through the whole solids and fluids, making a necessary constituent part of them, and form-

ing with them a perfect whole."—The terms in which this doctrine is proposed are hardly more intelligible than those in which he argues about the life of the blood; the matter itself, resembling the substance of the brain, is supposed! the manner of its union with the blood, is supposed! its connection at once with the fluids, and with the living solids, is supposed! the sort, of a manner, in which this matter harmonizes the whole, is supposed! and now the coagulation, and life of the blood, is no longer an effort of the life of the blood, but of the materia vitæ diffusa; and the blood does not form the solids, the blood no longer communicates life to the solids, but the blood and the solids are both at once animated by this DIFFUSED PRINCIPLE OF LIFE.

No one need triumph over a doctrine which thus falls by its own weight; but this must not be forgotten, that the doctrine of the life of the blood leads to a mean contracted narrow view, not merely of this but of higher subjects.

Plants have active and irritable fibres; by the most curious actions they drink in water; water alone they can convert, by the most simple mechanism, into the most delicate perfumes, into delicious fruits, or into terrible poisons. "There stands," says Blumenbach, "a hyacinth before me; generations of these flowers, of which this is the last, have grown there successively, touching the surface merely of a little water;" but shall Mr. Hunter persuade me that this water is alive? "vel hyacynthi me monent.*"

* Page 27.

I think

I think I may safely conclude, that these theorists have done the science no good; themselves no honour; and us no kind of benefit, unless it be an advantage to know that by none of these ways can we arrive at a knowledge of the blood.

## QUALITIES OF THE BLOOD.

Blood is a fluid of a rich and beautiful colour; it is vermilion-coloured in the arteries, strong purple in the veins, and black, or almost so, at the right side of the heart; it feels thick and unctuous betwixt the fingers, is of a slightly saline taste, is various in various parts of the body, in the heart or at the centre of the circulation different from what it is in the glands, excretories, and all the extremities of the body; different in the liver, among the intestines, in the cheeks, and lips, in the reservoir or sinuses of the head and womb. In various individuals, but much more in different animals, it varies with their functions and manner of life; it is more or less perfect in animals, in birds, in fishes, in insects; it is thick or thin; has gross particles or small; is red or pale; hot or cold; according to the creature's life: and from this last variety, viz. of the manner of life: comes our division of animals into those of hot and cold blood.

It is by the most simple and natural methods that we examine the blood; since almost spontaneously it resolves itself into three parts; the CRASSAMENTUM, the SERUM, and the RED GLOBULES; for in a cup of blood the crassamentum, or clot, the hepar sanguineum, as it was called long ago, floats in the serum;

the red globules are engaged in this clot, and give it colour; the serum may be poured off, the coagulum may be washed till it is freed of the red parts of the blood; and then the red particles are found in the water with which the coagulum was washed, and the coagulum remains upon the strainer, little reduced in size, pure and white, the gluten or fibrous part of the blood. Or we may separate this part by a method which Ruysch first taught us; we may, while the blood is congealing, stir it with a bunch of rods, when the pure and colourless gluten gathers upon the rods and the serum, with the red particles suspended in it, remains behind.

## OF THE RED GLOBULES.

The red globules, as we have observed,are not universal; yet in all creatures, even in colourless insects, there seem to be formal particles in the blood; in white insects, they are white, in green insects they are green, in most insects they are transparent.

The red globules of the human blood are easily seen; they are best examined with a simple lens, the globules being diluted in serum, and laid upon an inclined plane, not in water which dissolves them quickly, but in serum, which has the property of preserving their globular form.—The size of the particles of the blood varies in various creatures; in the fœtus, they are bigger than in a grown animal; and although Leeuwenhoek thought it essential to his doctrine, to say, that they were alike in all creatures, we know beyond a doubt that there are in respect to the size of the

animals

animals the strangest reverses. The Skate has red globules much larger, and the ox has globules much smaller, than those of a man Fish have large globules, serpents smaller ones, and Man smaller still. In Man the diameter of each globule is much less than the three thousandth part of an inch.

There is in the effect of lenses, or in the nature of these globules, some strange refraction, by which there seems a darkness in the centre of each globule, and thence a deception which has been universal; so that no single description has tallied with that which went before. Leeuwenhoek believed that he saw them consisting each of six well compacted smaller globules: Hewson believed that they were bladders, which had within them some central body, loose and moveable; that often the central part might be seen rolling in its bag; and that sometimes the bladder was shrunk and shrivelled around the central body, and could, by putting a drop of water upon it, be plumped up again. The Abbé Torre examined them with simple lenses too; but they magnified so highly, that from this cause all his noisy mistake has arisen; for he used not ground lenses, but small sphericles of glass formed by dropping melted glass into water: they magnified so much, that to him the central spot appeared much darker; he said that these were not globules, but rings. He sent his sphericles of glass and his observations from Italy, his own country, to our Royal Society; and for a long while, though nobody could see them, still the public were annoyed by Abbé Torre's rings. Falconer, with all the zeal of a friend, published Hewson's discoveries after he was dead; lamenting, as we all must do,

do, the loss of a promising young man. Falconer thought he saw these globules, not as spheres but as flattened spheres; he thought he saw them often as they rolled down the inclined plane upon which he placed them, turning their edges, their sides, their faces, towards the eye; he even compared their flatness with that of a coin. Many authors have conjectured that these globules are compressed when they come into narrow passages, and expand again when they get into wider arteries. This Reichell says he has seen, and Blumenbach believes; but Blumenbach, less easy of belief with regard to all these strange forms ascribed to the particles of the blood, pronounces his dissent in plain terms. "They appear," says he, "to my eye no other than simple globules, apparently of mucus; that lenticular or oval form which authors speak of, I have not seen."

The following are their chief properties with regard to the rest of the blood. When blood stands, they fall to the bottom, because they are heavier than the other parts of the blood; and although the gluten entangles them while it is forming, still it is to be noticed that the cake is always redder at the bottom; and when by weakness or disease this coagulation is very slow, some globules escape the grasp of the coagulum, and the serum is tinged with red, and the cake, though coloured at the bottom, is white at the top, or has the buffy coat. Their form they preserve only while in the blood, and seem to be supported more by the qualities of the serum than by their own properties; for if mixed with water, they mix easily, and totally dissolve; the water is red, but the globules are

gone;

gone; when we mean to preserve their forms for experiment, we must keep them in serum, or must make an artificial serum by impregnating water with salts. Their quantity, in regard to the whole mass, varies so, that the appearance of the blood is a real index of health or disease: in disease and weakness, the blood is poor and colourless; in health and strength, it is rich and florid; by labour, red particles may be accumulated in a wonderful degree: in hard working men they abound; they may be accumulated by exercise into particular parts, as in the wings of Moorfowl or Pigeons, and in the legs of common Hens. In short, the red globules are numerous in health; in large and strong creatures; and in the centre of the system, where they often circulate when (as in fishes) all the flesh is colourless; in such a system, particular glands only, or viscera, as the liver, stomach, or spleen, are coloured with blood, and but a small proportion circulates in the great vessels round the heart.

The redness of these particles is a peculiarity for which we know no meaning nor cause. The greatest physiologists have ascribed it to the iron of the blood; but when we reflect how many various colours iron gives in its various states; when we reflect, that the unknown cause which gives colour to the iron may give colour to the blood; when we reflect that of this crocus of iron we can hardly procure one poor grain from four hundred grains of these red particles of the blood;—we cannot but be conscious that this peculiarity is not yet explained.

COAGU-

## COAGULABLE LYMPH.

The coagulable part, the cake which is left when we wash away the red globules, is by far the most important part of the blood, the most universally diffused in the animal system, the most necessary for the supply and growth of parts. It forms all the solids, and in its properties resembles them most curiously; for this cake, when washed, is white, insipid, extremely tenacious, and very fibrous; can be drawn out greatly; and it is the coagulation of this part that makes the long fibrous strings which we find in the tub when bleeding a patient in the foot in very hot water. Being slightly dried, it shrinks into a substance like parchment; being hardened by heat, it becomes like a piece of horn or bone; when burnt, it shrinks and crackles, with a very fetid smell, like the burning of feathers, wool, flesh, or any other animal substance; by which we know it to be the part of the blood which is the most perfectly animalized, and the most ready to be assimilated with the living solids. When distilled, it gives ammoniacal salt and alkaline water, and a very thick heavy fetid oil, and much mephitis, which are the marks of the most perfect animal nature; and after burning it, the residuum is a phosphate of lime, or, in other words, the earth of bones.

Its peculiar properties, as it appears in the blood, are few; its relation to the body is very surprising; how the body acquires, and how it applies, this most important part of the blood, we shall next explain.

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There is no part of our food which does not contain this gluten in a large proportion. With regard to animal food, this is to be remembered, that except the fat and the earth of bones (which is in a wonderfully small proportion), the whole is gluten. A piece of animal food we can first wash clear of its blood till it be colourless, and then boil with a strong heat till it is converted into jelly merely. Eggs contain an animal gluten separated and entirely formed; the final use of which is to enter into the intestines of the chick, and nourish it. Milk contains in its curdy part a perfect gluten, which is easily separated, and when perfect coagulates with acids like blood. Oysters, shell-fish, fishes of all kinds, are so entirely formed of gluten, that many of them can be boiled down to a perfect jelly. With regard to our vegetable food, this is to be remembered, that much of it is already formed into gluten, and is ready to be assimilated into an animal nature. If we knead up flour with cold water into a cake, the washing of that cake resembles the process of washing a coagulum of blood; for while we hold it in our hand, and pour cold water upon it, the water as it runs off carries along with it a white amylaceous matter, which is starch; along with this there is much saccharine and mucilaginous matter; but the most dense and solid part of the cake remains in the hand. This is the gluten of the vegetable left alone, just as the gluten of the animal is washed pure of the red blood; and this vegetable gluten is very tough, so that the whole cake may be drawn out into one long string. It is so tenacious and so hard when dry, that it has been long used as a cement; and it so precisely

resembles

resembles the animal gluten, that, put them together, and you can see no distinction. It shrinks also with heat, and is converted into a substance like parchment or horn. It first melts with heat, and then burns like feathers or hair; and by distillation it gives only alkaline ammoniacal salts and fetid oils; it wants no mark of perfect analogy with our animal gluten, and we can be at no loss to think whence all our necessary supplies arise: and flour, though it is the richest, in this highly nutritious part scarcely exceeds corn, barley, potatoes, pease and beans, and all those vegetables called legumina, upon which chiefly we depend for bread, or a substitute for bread. These do not, indeed, contain this vegeto-animal matter directly or entirely formed; but they consist of a jelly analogous to all the white or gelatinous parts of the human body; as vegetable jelly, it has a vegetable character, it ferments and becomes acid; while animal jelly, as belonging to the animal body, has other characters, it becomes putrid, and affords alkalis only: but how easy this conversion must be, I need hardly suggest.

What passes within the animal body, or how this gluten is directly applied, we never can know; but we see how all the body is composed of gluten, and no analysis of any single part has ever disappointed us. A muscle being squeezed, and thoroughly cleansed of blood, washed in spirits of wine, and again cleaned, is seen plainly to be but a peculiar form of coagulable lymph. An anatomical preparation washed, and purified as it is, consists of mere lymph retaining its primitive shape. A bone being infused in any mineral acid, or in vinegar, its earthy parts are dissolved

dissolved even to its centre; it becomes soft and flexible, still retains the form of a bone; but what remains is merely coagulable lymph. And though Fourcroy is certainly right in saying the coagulable lymph is that part upon which nature fixes irritability or the contractile power, he should have added, " but this gluten is moreover in the animal body the basis of every part which possesses life;" it constitutes, in truth, no less than nine tenths of the solids of the whole body. The membranes, ligaments, tendons, periosteums, and all the white parts of the animal body, consist entirely of this; and it is the business of cookery to boil them down into this jelly. It is this fibrous part, then, which is secreted by the vessels for repairing all the wastes and all the accidents of the body; when a muscle is wasted by violent action, or by fevers, or by long confinement is absorbed, gluten is secreted to fill it up; when a bone is broken, much of this jelly is deposited in a bed for vessels to stretch into, and a new bone is quickly formed; when soft parts are cut, gluten is poured out betwixt them; when viscera are inflamed, pure gluten, white, and membranaceous-like, is poured out betwixt them; when the uterus is to be prepared for receiving the impregnated ovum, gluten is poured out into the womb; and in all these cases it is the foundation of a union with the surrounding parts. In short, this gluten forms, nourishes, supports, restores the parts of the animal body; but far from considering it either simply, or along with red globules, as containing the principle of life, I find it as perfect in dead vegetables

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as in living animals; and view it only as that particular form of matter which nature has wisely appointed for our chief nourishment and support.*

## THE SERUM.

The serum is the thinnest and most fluid part of the blood, which dilutes the other parts, and receives all those extraneous substances which often circulate in our system: this must be kept in view when its properties are to be told, for though it so exactly resembles the white of an egg, that some have in com-

* It will easily be perceived, that here I choose to sink, in this general description, all those lesser distinctions which are so imperfectly proved. Distinctions betwixt the gluten and the albumen or serum in animals, or betwixt the vegeto animal gluten and the starch in vegetables, I hold to be very vain; these are but various stages of the same product; what is less perfect in the albumen, is more perfect in the gluten; and a little more or a little less of the oxygene or acidifying principle, makes perhaps all the difference: these parts, as they are more or less perfect, contain more or less of this principle, and are more or less ready to congeal; both kinds of jelly, when treated with nitrous acid, give out azotic gas; azotic gas, united with hydrogene gas, forms the volatile alkali; and the giving out of this azotic gas to nitrous acid, or the forming of the volatile alkali in the act of putrefying, are the chief tests by which animal matter is known. Then to make formal distinctions betwixt the tendinous and the fleshy parts of animals, and to call the first gelatinous and the latter glutinous parts, as formed of the proper gluten, seems very vain; and not less so to make essential distinctions betwixt the gelatinous parts of vegetables and those of animals, since the slight change of proportion of azot or oxygene must make the whole difference when these vegetable jellies are assumed into the living system and completely analysed.

paring

paring the two, written whole pamphlets upon the subject, and named it the Albuminous Fluid, although it coagulates like gluten, although it putrefies like flesh, although it gives out upon distillation ammonia and a black and fetid oil; yet it is most natural that along with these it should contain also some foreign bodies, as a saccharine or extractive matter, belonging to vegetables, and some proportion of the oxalic, malic, or other vegetable acids.

Serum or the albuminous fluid is like whey, of a yellowish, or rather greenish colour, of an unctuous or slippery feeling among the fingers; it is slightly saline, and its salt is chiefly of an alkaline nature; it contains soda completely formed, by which it turns vegetable reds to green; it coagulates firmly with a heat much lower than that which makes it boil: being dropped into hot water, it coagulates as it falls; by 150 degrees of heat it coagulates into an albumen like the white of an egg; but if gradually evaporated, the cake which remains is quite similar to the gluten of the blood. It is upon this alkali that the fluidity of the serum seems to depend; spirits of wine do indeed seem to congeal the blood, but it is not a true coagulation, since it depends merely on the avidity of spirits for water, by which the spirit of wine takes the water to itself, thickens the serum, and makes the whole turbid; but acids produce a true coagulation by seizing that alkali on which the fluidity truly depends.

To say that lime coagulates the serum, but melts down the lymph, is by no means to establish a rational distinction betwixt the cake of gluten and this gluten

which the serum holds dissolved: till some decisive difference be proved important to the whole system, I cannot but believe that they are one; nor can I, when I see the water which washes the coagulum impregnated with gluten, believe that there is any difference. Yet we need not wonder that such ignorant unmeaning distinctions as these should have been made, since the halitus of the blood, or that vapour which rises from it while it cools, was examined with a most ludicrous affectation of accuracy, though it is merely water alone, having a slightly urinous smell, from its connection with the blood.

The serum dilutes the whole mass, and no other fluid can we find so fit to hold in solution a proportion of gluten, or so fit to support the form of the red globules, or so fit to pass easily and smoothly along all the delicate vessels, without exuding through the pores. For in truth it is with the serum as with our injections; if we inject simple water, it exudes at every pore, and the whole cavities are filled, and the whole body swelled and bloated; but when we mix size, *i. e.* gluten, common glue, with our water, it penetrates to the extremest parts, yet still keeps in the channels of the arteries, and often returns by the veins.

The whole fabric of the blood should now be exposed in one continued view, consisting of three distinct parts, whose uses are these:

First, we see the SERUM diluting and tempering the whole, preserving its lubricous and fluid form, containing and dissolving all foreign matters which may have got access to the system, and running them off by various excretories; for the secretions are chiefly from

from the serum, containing gluten enough to support the tenuity of the blood, salt enough to keep the red globules in their form, and conveying also a sufficiency of lymph into the most delicate and bloodless parts of the body: and this above all is a most singular property of the serum, that it admits freely the air to pass through and impregnate the blood; for when the coagulum of the blood is drowned deep in its serum, if turned up and exposed to air it reddens; which, if oil, mucilage, water, or any other fluid, be substituted instead of serum, it will not do.

Next, we see the red globules of large diameter, but in quantity very small, *i. e.* in proportion to the whole system; of large diameters, that they may not go into the very minute vessels, and in small quantities, because they are accumulated round the heart, and in the greater vessels.

And, lastly, the gluten is the most important part of the blood; that which, being dissolved in the serum, pervades even the most exquisite vessels of the system; the part from which all our solids are formed, and into which all our solids, and even fluids, can be resolved. But allowing for the various proportions of the water which dilutes the serum and the red globules (whose proportion to the fluids cannot be named it is so small), and some saccharine or extractive matter which is in the serum of the blood—what is there except gluten in all the animal system? Serum, coagulum, flesh, tendons, ligaments, bones, all are composed of it; and when gluten is thus united to the solids, forming with them one individual body, it acquires new powers, and is indeed alive.

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This analysis of the blood contains the analysis of almost all the humours or secretions of the body. Observe how nearly the urine resembles the serum, indeed the urine, like the serum, preserves the peculiar form of the red globules, and sweat is but a serum loaded with salts; observe how little saliva differs from the serum; observe how perfectly the serum resembles milk, since mixing serum with water produces a milky fluid, that is, a fluid which gathers cream on the top, and coagulates with acids and heat. The water of dropsies is purely serum; the mucus of hollow passages is little else than inspissated serum; the bile itself is said to be imitated by keeping putrid blood. In short, it is obvious that on the coagulable lymph depend all the internal secretions, *i. e.* for supplying the wastes of the system, for enabling it to grow, for repairing bruised or cut flesh, or broken bones; that on the serum which dilutes the blood, and contains all such foreign bodies as might be injurious to the system, all the excretions, as urine, sweat, saliva, tears, &c. &c. depend*.

* When the blood and solids of animal bodies come to be resolved into their ultimate parts, we find a variety of combinations which belongs to another science, and which in this place it were tedious to explain. But still there is one great distinction betwixt animal and vegetable matter, which should not be left unnoticed. Animal matters always, when dissolved by nature, fall into a putrid state, and give only volatile alkali. Vegetables, when they dissolve, fall into fermentation, and produce acids or wine; not that alkalis are necessarily contained in their formal state in the animal body, but that the animal body contains much mephitis or basis of nitrous air, which, combining with the inflammable air afforded by decomposed water or by their oils, forms the volatile alkali.

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I have said, "that the blood is a fluid of a rich and beautiful colour; vermilion-coloured in the arteries, strong purple in the veins, and black, or almost so, at the right side of the heart." When we open the thorax of a living Dog, the lungs collapse, the heart soon ceases to play, the Dog languishes, expires, is revived again when we blow up its lungs:—then begins again the motion of the heart, the black blood of the right auricle is driven into the lungs; the blood goes round to the left side of the heart of a florid red; and this purple blood of the veins, the vermilion blood of the arteries, the change happening so plainly from access of air, is a phenomenon of the most interesting nature, and binds us to look into the doctrines of chemistry for the solution of a phenomenon to which there is in all the animal economy nothing equal.

It is the study of air and aërial fluids that has brought to light all the beautiful discoveries of which modern chemistry can boast. The simplicity of the facts in chemistry, the correctness of the reasoning, the grandeur which now the whole science assumes, is very pleasing; and makes us not without hope, that by this science, all others, and ours in an especial manner, may be improved; for the action of vessels will do much in forming and changing our fluids: all the rest is chemistry alone.

The older chemists were coarse in their methods, bold in their conjectures, in theory easily satisfied with any thing which others would receive. They condescended to repeat incessantly the same unvarying process over each article of the materia medica; and

among hundreds of medicinal plants which they had thus analysed, they could find no variety of principles, nor any other variety of parts and names than those of phlegm, and oil, and alkali, and acid, and sulphur, and coal. By this they disburthened their consciences, of all they knew, pleased their scholars, and set the physicians to work, forming magnificent theories of salts, sulphurs, and oils; for such has ever been the connection of chemistry with physiology, that good or bad, they have still gone hand in hand.

The older chemists thought that they had arrived at the pure elements while they were working grossly among the grosser parts of bodies. They could know nothing of the aërial forms of bodies, for they allowed these parts to escape. When their subjects, by extreme force of heat, rose upwards in the form of air, no further investigation was attempted; it was supposed that the subject of their operation was consumed, annihilated, wasted into air, and quite gone. When they thus stopped at airs, they stopped where only their analysis became interesting or simple; stopping where they stopped, among their oils and sulphurs, they made their science a mere rhapsody of words. Philosophy they considered so little, as not to know that the lightest air is really a heavy body, and that with weight and substance other properties must be presumed.

Modern chemistry begins by assuring us, that these airs are often the densest bodies in the rarest forms; that airs are as material, as manifest to the senses, as fairly subject to our operations, as the dense bodies from which they are produced: That it is heat alone

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(a substance which irresistibly forces its way into all bodies) that converts any substance into the aërial form: That some bodies require for their fluidity merely the heat of the atmosphere, and so cannot appear on this planet in any solid form: That others require some new principle to be added, in order to give them the gaseous or aërial form: That others require very intense heat to force them into this state; but that all aërial fluids arise, or must be presumed to arise, from some solid body or basis, which solid basis is dilated by heat into an air. The solid basis of some airs can be made apparent, as of fixed air which proceeds from charcoal; others, as pure air, or azotic air (the great constituents of our atmosphere), cannot be produced to view into any solid form. But those airs which cannot be exhibited in any solid form, can yet be so combined with other bodies as to increase their weight, and give them qualities of a very peculiar nature; and these airs can be alternately combined with a body and abstracted again, adding or abstracting from its weight and chemical properties, not only in a perceptible, but in a wonderful degree; so that these abstractions and combinations constitute some of the most general and important facts. When the old chemists, then, neglected to examine these airs, they refrained from examining the last elements of bodies at the very moment in which they came within their power.

That these must be the most material and important facts in all the science, it is easy to explain; for chemistry, ever since it has been a science, has rested upon one single point. There are certain great ope-

rations in chemistry which we perceive to have the strictest analogy with each other, or rather to be the same; the operations are, the combustion of inflammable bodies, the respiration of animals, the calcination of metals; and whatever theory explains one explains the whole. The older chemists observed, that when they burnt an inflammable body, the surrounding air was contaminated, the substance itself was annihilated, nothing remained of its former existence but the foul air; and they supposed that this inflammable body consisted of a pure inflammable principle, which was the substance which spoiled the air, lessening its bulk, and making it unfit for supporting any longer either combustion or animal life. When an animal breathed in confined air, they found the phenomenon still the same; the animal contaminated the air, and expired itself; left the air unfit for burning or breathing, loaded, as they supposed, with the inflammable principle. When they calcined a metal (which is done merely by heating the metal and exposing it to air), they found, as in these other operations, the air contaminated, the metal losing its metallic lustre, ductility, and all the marks of a metal,—acquiring (in certain examples) new qualities, like those of some mineral acid, and becoming of course a most caustic drug; but above all, they uniformly observed the metal to increase in weight.

To account for all these discordant changes was the most difficult part of all: it was indeed easy to say, that combustion was the giving out of an inflammable principle to the air; and to say concerning respiration, that it was the business of the air to take

away continually the superabundant phlogiston of the blood; but how a metal should pass from a mild to a most acrimonious and caustic state; and above all, how by the loss of its inflammable principle it should not lose in weight, but increase in weight! This was the Gordian knot which they had to untie, and which they cut lustily, betaking themselves, in defiance of all philosophy, to the absurd project of a principle of absolute lightness. They all agreed to call the phlogistic principle a principle of absolute levity; and thus their doctrine stood for many years, viz. that when phlogiston, or inflammable principle, was added to the calx of any metal, as to red lead, by roasting it with any inflammable body—the metallic lustre, tenacity, ductility, were restored, and the metal became lighter withal, because it now had within it the principle of levity. But that when by heat and air it was calcined, this principle was driven out, and then the metallic lustre, tenacity, ductility, &c. were lost by the absence of the inflammable principle upon which they all depended; but the weight of it was increased, for the principle of levity was gone. This is the brief abstract of the theory to which the very best chemists have addicted themselves down to the present times.

But the chief perfection of modern chemistry is, that its apparatus is so perfect, that it can employ exactly a certain quantity of air in calcining a metal; it can collect that air again to the twentieth part of a grain; it can prove whether the metal has really been giving out any inflammable principle to the air, or whether it has received matter from the air, and

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how much expressly it has gained or lost. Modern chemistry proves to us, that it is not the loss of any principle that endows a metal, for example, with negative powers; but the direct acquisition of a new principle, which endows it with positive powers. Thus if you take a quantity of mercury, and expose it slowly, that is, for a long time to heat and air, the following changes take place; it gradually loses its metallic lustre, the upper part of it assumes first a yellow and then a red colour, small red particles are seen floating on the surface of the mercury; and these are the mercurius precipitatus per se, a most acrid calx of mercury. If, first, you estimate how much air has been expended during the process, you find that the weight of the mercury is increased in exact proportion; if you put that calx into a gun-barrel, put the gun-barrel into the fire, and by mere force of heat drive out this air, you find the quantity of air, exactly equivalent to the quantity expended in the process; you find the metal grow lighter, and recover its metallic qualities and lustre in proportion as the air is expelled. In short, we find the metal heavier when combined with air, lighter when the air is driven out; we find it having the qualities of a metal when uncombined with air, when combined with air having the qualities of a calx: then plainly this caustic form of the metal is not a negative quality, it is a positive one, proceeding from the infusion of this new principle from the air.

By such proofs as these chemistry has explained, in a most philosophical way, how all these phlogistic processes, as they were called, depend, not on the

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abstraction of phlogiston, but on the addition of a new principle: That they all arise from one positive power, that the same principle gives life to fuel, heaviness (and other effects of calcination) to metals, acidity to acids, and redness to the blood. These are all performed by one power; they are all essentially one process; they are all effected by the communication of one sole principle, viz. the basis of pure air.

Upon our atmosphere and its surprising harmony with all parts of nature; with animal and vegetable life; with water, metals, acids, and all the solid bodies into which it enters—much more depends than it is easy to conceive. Could we have supposed that it was the cause, not merely of life in all living creatures, but almost the cause of all the properties that reside in the most solid forms? Could we have supposed that the air rendered heavy bodies heavier, changed metals into caustic earths, converted many bodies into acids, changed inflammable air into the pure element of water, which at least we have hitherto conceived to be pure? Yet, if there be one word of truth in chemistry, all this is true.

The atmosphere contains various gases or airs; but one only, viz. vital air, is useful to respiration, combustion, and animal life; that purer air must, like every other, arise from some solid basis: That basis cannot be shown in any substantial form, but it can be combined with many various bodies, so as to give then an increased weight and new qualities: and thence we presume to say, whenever we see a body, by such a process, acquiring such qualities, that

that it acquires them by absorbing the basis of pure air; for pure air is nothing but this presumed basis dilated into the form of air by heat; and when it combines with any body, it gives out its heat; so that in all these processes heat is produced. And although inflammable bodies, metals, acids, and animal blood, seem very distinct from each other; although combustion, breathing, calcination, and the forming of acids, are processes seemingly very unlike; yet they are in all their essential points the same, viz. a change of qualities and a production of heat in consequence of the absorption of pure air.

First, when an inflammable body is BURNT or consumed by fire, the basis of pure air is combining with the combustible body; the air is entering into a new combination, and therefore must give out its heat; it combines rapidly, gives out its heat rapidly, is wasted; the inflammable body burns and seems to be consumed: but if we catch that air which escapes from the inflammable body, we find it to be equal exactly to the whole weight of the air and of the burning body that have been consumed; and this air consists of two parts, viz of the substance which was burnt, and of the basis of pure air. Thus, for example when we burn charcoal or carbon, the whole substance of it, weight for weight, is converted into an air, which is called fixed or fixable air; the same which is discharged from stoves, the same also which is found in pits, the same which oozes through the ground in the Grotto del Cane, the same which floats upon the surface of fermenting vats, and which is so much heavier than common air that it can be taken

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out from a vat in basons, and poured from dish to dish. Combustion, then, is a process which consists in the rapid assumption of the basis of pure air, and a consequent conversion of the burning body into an air endowed with peculiar qualities and powers.

If, then, the oxygenation of the blood be a process like this, it must differ chiefly in degree; it might in certain circumstances become too rapid, and resemble an actual combustion; and so in certain circumstances it does, for our atmosphere is so tempered that no more than 27 parts out of 100 consists of pure air; the rest is food for vegetables, but not fit to maintain flame or animal life. This is the reason that even burning as well as breathing are slow processes, and that an animal, if made to breathe pure air, or vital air as it is called, gets the basis of air too rapidly united to its system, is consumed and inflamed quickly, and dies.

Secondly, the process of CALCINATION is the same in all metals; it also is an assumption of the pure air, or rather of its basis, with a change of qualities and increase of weight: if you calcine lead slowly, it becomes first yellow, then orange, then red; it becomes heavier, so that from 100 pounds of lead you have 110 pounds of lytharge, or calx of lead: if you calcine mercury, it also becomes first yellow, then red, and much heavier than at first: if you distil any of these metals, you can by heat merely drive out the purest air from them; they recover their brilliancy and grow lighter, because the basis of air is expelled. The basis of pure air is expelled, not in that solid form in which it was embodied by the calx, but be-

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ing now combined with heat, it appears in the form of vital air; the air is much purer than that of the atmosphere which was used in the process, because the metal absorbs or appropriates to itself nothing but the purest air, leaving the azotic or foul air behind: and finally, if you wish to see the harmony betwixt combustion and calcination, or to be assured that calcination is truly the burning of a metal, take some of this pure air, which is three times purer than the atmosphere, and raises an intenser flame; plunge into it a piece of iron wire, which is made red-hot; and this wire (which would only have wasted or rusted into a calx in the common atmosphere) will in the pure air burst out into a brilliant white flame, and burn entirely while it has such air; nay, some metals, as zinc, burn even in our common atmosphere with a most brilliant flame.

From this second process, must it not be presumed that the principle which gives an increase of weight and such singular properties to various metals, must have very interesting effects upon the blood?

Thirdly, it is from this principle also that all acids are formed; and as oxyd is the Greek name for acid, the great Lavoisier has thought fit to give a name to the basis of air, or that principle which is obvious only when operating in such processes as these. He adds to the Greek name for acid that verb which implies the generation of any substance; he calls it thus oxygene, or the principle which generates acids. It were easy to show how truly this great point is supported by all the particular operations in chemistry; it shall be sufficient to observe a few. When we burn sulphur

phur in open air, it seems to be consumed; but when we burn it in close vessels, still giving a free access to air, we find it converted into an acid the most ponderous of all, weighing greatly more than the sulphur from which it was procured. The operation is done in close vessels; nothing can pass but what is known, and nothing is more certain than that the whole of this wonderful and rapid change is the mere effect of the sulphur, which is an acidifiable base, assuming the acidifying principle by which alone it can become an acid. Phosphorus being burnt in a close glass upon the point of a wire, the vital part of the atmosphere is consumed, the azotic air (which the ancients mistook for their phlogiston) remains, the whole phosphorus is changed into phosphoric acid, and the whole acid when weighed expressly equals the phosphorus which was burnt, and the air which was consumed along with it. Nay, arsenic, which is a metal, being calcined, is converted into a perfect acid. Thus we see, first, that calcination is a mere combustion, since it can be made so rapid as to be attended with heat and flame; next we see that acidification is, like calcination, attended with heat and flame, and an acquisition of weight and of properties like those of calces. We see some metals converted into proper acids; acids and metals mixing in qualities with each other; acids and metals are both acidifiable bases, both are capable of receiving new and similar properties, by assuming into their composition the basis of pure air; and in one single process the whole set of phenomena are exemplified, for in burning arsenic we have combustion,

calcination,

calcination, and generation of acid, all in one process, the product being named indifferently oxyd of arsenic, or white calx of arsenic*.

But if most acidifiable bases be thus forced by combination to forsake their solid and assume their aërial form, others more singular still are recalled from their aërial form, and condensed into the fluid form of a strong acid. Thus azotic or nitrogene air, which forms the great bulk of our atmosphere, is converted by oxygenous or pure air into an acid form†; it becomes nitrous acid, nitric acid, nitrous air, strong or weak according to the various degrees of oxygenation communicated to it; and thus nitrous air, by its appetite for oxygene, and by its change of colour and its condensation, whenever it takes oxygene from the air, makes a eudiometer or measure for the purity of the air; and, according to the purity of the atmosphere, more turbidness and more redness is produced in the nitrous air, and a greater loss of bulk, which may be marked on a scale.

Thus are all acids formed of an acidifiable basis, various each according to its kind, on which the variety of acids depends; but these all become acid by the addition of one uniform principle, viz. the basis of pure air,

* It is necessary to add nitre to make it burn. The result is not directly an acid, but a neutral salt formed of the arsenical acid joined to the alkali of nitre; without the help of nitrous acid it is only an oxyd or imperfect acid; and it is necessary to use the hyper-oxygenated muriatic acid for communicating to it a sufficiency of oxygene to constitute it a perfect acid.

† *N. B.* It is necessary to inclose them in one vessel, and to pass the electric spark through them that they may unite.

air, which is the cause of acidity in all bodies: and this third great fact in chemistry may well suggest to us a higher view of our present subject; for this principle, which bestows weight and causticity on metals, acidity on acid bases, and new properties on all it touches, must make similar, or at least important, changes on the blood, converting it into an oxyd or subacid; and we may fairly begin our next general fact under the title of the oxydation or oxygenation of the blood.

The oxydation of the blood makes a fact no less important in physiology than those are in chemistry; for as there are various marks of the influence of oxygene on the blood itself, there are terrible proofs of its importance in the system, and how miserable the person is who has imperfect organs or an ill oxygenated blood.

Nature, disregarding all occasional supplies, as by the absorption of the skin, the assimilation of aliments, &c. has appointed one great organ for the oxygenation of the blood, viz. the lungs. In opening the breast of a living creature we best see the connection of respiration with the great system; but it is out of the body that we can best understand its particular effects upon the BLOOD.

The most obvious effect of air is its heightening the colour of the blood. If we expose blood to fixed air, or azotic air, it continues dark; these fluids communicate nothing, they have no effect on the colour of the blood: when we expose blood to atmospheric air, it assumes a florid colour; for in the atmosphere there is a large proportion of oxygene gas: if, lastly, we expose it to oxygene gas, the purest of all air, it

grows extremely florid; and whenever it changes its colour, it is by absorbing oxygene, for it reduces in the same proportion the quantity of air; what it absorbs is the oxygene or pure air, what it leaves is mephitis, unfit for combustion or animal life*.

Blood when exposed to the air becomes red chiefly on the surface, it remains black beneath, but by turning up the clot to the air all the surfaces become red. If air be blown into a tied vein, the blood which was black in the vein becomes florid; and when the air is pressed out again, it becomes black. If the air-pump be exhausted over a dish of blood, the blood becomes dark in the vacuum; and it becomes florid when the air is allowed to rush in again. If you expose blood in a moist bladder, the blood is oxygenated through the walls of the bladder; which brings this experiment as close as may be to the phenomenon of blood oxygenated through the walls of the lungs. Though serum or milk be interposed, or urine, still the blood is oxygenated, because these are perfect animal fluids; but it is not oxygenated if oil, mucilage, or mere water, be interposed.

When we open a Frog, or Newt†, or other amphibious creature, we see a long and slender artery, accompanied by a slender vein, running from top to bottom along the whole surface of their lungs; and while their heart continues to beat, we see this pulmonic artery black, the vein red, the lungs themselves most

* Mr. Beddoes, in his last Book, makes hydrocarbon as effectual in reddening the blood as oxygen air. What are we to think of this? Is it a freak of nature, or of the author?

† See Chap. III.

delicate

delicate and pellucid, like the swimming bladder of a fish: Even in the extremities of the human system the blood of a vein is dark, of an artery red; so that surgeons distinguish venous and arterial hemorrhagies in this way.

From these facts we may understand why the blood of the womb, of sinuses, of varices, and of all stagnant veins, is so offensive and black; and why that blood is so very pure and florid which is coughed up from the lungs. Is not the face livid in apoplexies or strangulations, in hanging or drowning, in fits of passion or of coughing, or in any accident which interrupts the lungs? The face of a child during a paroxysm of the hooping cough, is it not completely black? Is not the hand livid when the arm is compressed or tied up, and its blood prevented from returning to the lungs and heart? Are not tumours dark-coloured from dilated veins which return their blood too slowly? Are not those mulberry marks which are born with us just small aneurisms full of ill oxygenated blood?— Then this first effect of oxygenation is a reddening of the blood. The menstrual blood, the blood of ecchymosis (as in those who have been whipt), the blood of aneurismal bags, are all black; and the blood of varices is so very black, that the ancients said they were filled with atrabilis or black bile. The stripes inflicted on a soldier as a punishment are at first of the most lively red, but soon become black.

The next effect of oxygenation is the endowing the blood with a peculiar stimulant power; by which it is continually operating upo . the living solid: this is a power which it is continually losing; which it is

every moment giving up to the solids; and which no other process but respiration can restore. This stimulant power the blood gradually loses as it circulates round the body; it is quite effete when it returns to the right side of the heart: the heart of a creature never moves, if we allow its lungs to lie collapsed; but the heart returns to act the very instant that pure air is forced into the lungs, and so communicated to the blood. This stimulant power is most of all apparent when we force a living creature to breathe nothing but the purest air; for oxygenated or vital air makes this process too rapid; the pulse rises, the eyes become red and prominent, the creature seems drunk with the new stimulus, too great for its system. The universal heat of its body is greatly increased, the eyes are turgid and red, and at last a sweat breaks forth all over it; and when dead, the lungs (it is said) are mortified or inflamed. But whatever the marks are, whether these signs of inflammation be really true, it is plain, since the creature dies, that pure air is fatal by a too rapid oxygenation of the blood. If, in our experiments upon a dying animal, we inflate the lungs with mephitic air, the heart does not act; if we inflate its lungs with common air, the heart begins to act; if we inflate its lungs with oxygene air, the heart is irritated to a still more powerful action.

If we open the breast of a Frog and stop its breathing, we observe, first, its pulmonic blood florid, and the heart beating strongly: Secondly, in half an hour the pulmonic blood has become dark, and the heart's motion has grown languid; in a little, while the pul-

monic

monic blood becomes black, and the pulsation of the heart ceases: And, lastly, the trachea of the Frog being untied, and the creature allowed to breathe again, the blood becomes florid, and the heart acts.

OF THE HEAT OF THE BLOOD.

The next effect of oxygene is said to be the communicating of HEAT to the lungs. But I suspect that if the small quantity of oxygene which can enter by the lungs do communicate heat, it must be not to the lungs, nor to the blood, but to the whole body through the medium of the blood. There are some who pretend to say, that when they draw in vital air, they feel a genial warmth in the breast, diffusing itself over all the body; but it is easy to feel in this way, or any way, when a favourite doctrine is at stake, while those who know nothing about doctrines breathe the vital air without any peculiar feeling which they can explain.

There are many circumstances which make it hard to believe that there is, in consequence of the oxydation of the blood, any remarkable generation of heat in the lungs. Oxydation of the blood, out of the body, is attended with no increase of heat, and yet we operate on a quantity of blood much greater than that which circulates through the lungs. We call this process not the oxygenation, but the oxydation of the blood, because we are conscious that it is an imperfect process; it is perfect, indeed, with regard to its ultimate object, viz. that of communicating oxygene to the whole body; but as an assumption of the acidifying principle into the blood itself, we see it to be so imperfect, the union so slight betwixt the oxygene and the blood, that it parts

with it very easily; the blood turns black again if its colour be not supported by the perpetual contact of air; it is so imperfect, that we put it in the lowest point of saturation, and call it an oxyd or imperfect acid; and how far it may be below the denomination even of an oxyd we do not know.

To suppose, but for a moment, that all the heat which warms the whole body emanates from the lungs, were a gross error in philosophy; it were to suppose an accumulation of heat in the lungs equal to this vast effect of heating the whole body. But were it so, we should feel a burning heat in the centre, a mortal coldness at the extremities, and marked differences in the heat of each part in proportion to its distance from the lungs. In fevers, we should feel only the intense heat of the centre; we should be distressed, not with the heat in the soles of the feet or palms of the hands, or in the mouth and tongue; we should feel only the heat of the lungs. When the limbs alone were cold, would the lungs warm them? How could it warm them up to the right temperature without over-heating the whole body? When a part were inflamed, how could the heat go from the lungs, particularly to that point, and rest there?

From the lungs the heat could not be regularly diffused; for in almost all the Amphibiæ the lungs are far distant from the centre of the body, and could not communicate any degree of heat to the extremities without the greatest waste; they would, according to this theory, have lungs for crying with, if they pleased to cry, but by no means for distributing heat. Those who have been the chief supporters of this doctrine, viz. of animal heat emanating from the

lungs

lungs, have established their doctrines on very fantastical and absurd laws; not merely of chemical changes producing heat in the lungs, but of the blood acquiring a greater capacity for heat than those substances have from which the blood itself is formed. The blood is formed from flesh, milk, wheat, rye, barley, and various other foods: these are curiously measured; the degree of heat which they communicate to water is assumed as the truth of their absolute heat: the absolute heat of all kinds of food is declared to be greatly lower than that of the blood itself; and this accumulation of heat in the blood is taken as a sure proof, that in respiration much heat is deposited upon the blood, it having a greater appetite or capacity for heat.

But concerning this doctrine, which in its philosophical as well as in its chemical part is now antiquated it is allowable to say, more freely than of almost any other, that its intricacies are its beauties; that it is a hypothesis illustrated by experiments, which have no other tendency than "to make it look well in the face;" and which are made with such affectation of niceness as is completely ludicrous. The author pretends to measure, to the tenth part of a degree, the proportions of heat in wheat, barley, flesh, milk, &c. Airs he also measures, showing the various capacities for heat in the different kinds of air to the tenth part of a degree; a thing much fitter for a magician than a philosopher to undertake; and which Dr. Crawford has executed so ill, that we are teased, or rather thoroughly exhausted, before we begin, with correctin measures and instruments and settling data; while

each new edition of the book on animal heat must be prefaced with new apologies, new confessions, new corrections, new calculations, unhinging so entirely the conclusions and calculations of former copies of it, that we find ourselves engaged, along with our instructor, in a wilderness of errors, from which we can have no hopes of being extricated.

Oxydation is a process which had no place in Dr. Crawford's views; he never conceived that it was the presence of oxygene, as a new principle, which gave colour, stimulant powers, coagulability, and all its most useful properties, to the blood; but he believed that pure air, uniting with inflammable air in the lungs, formed fixed air; and this fixed air being incapable of containing the heat which it had while in the state of pure air, that heat was deposited, or, as it were, precipitated upon the blood. He maintains, that there are of inflammable air two kinds; one capable of forming water, another of forming fixed air; but fixed air, derived from inflammable gas of any kind, all chemists will deny. He begins his doctrine, therefore, not with a fact, but with a petitio principii; and what is worse, his main experiment is wrong. He was extremely anxious to prove, that in proportion as air was changed by respiration, it gave out its heat to the blood; he also wished to put respiration and combustion on one level; and by this second thought he forgot entirely what he first had it in mind to prove. Accordingly, having inclosed a Guinea-pig in pure air, and under water, he found that the air which it had respired communicated nearly the same heat to water that burning the same quantity of air would

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have done: by which he proved much more than he intended; for he proved plainly by this, that all the heat which respiration can possibly generate is by the fixed air carried from the lungs, and he forgot to reserve any for going into the blood.

This slip of Dr. Crawford's leads us to perceive what becomes of any proportion of heat that may be generated in the lungs. In the first place, this respiration is not a rapid but a slow and gradual oxydation, for the quantity of pure air in the atmosphere is small. It is not a perfect oxydation, the blood bearing no marks of an acid, nor its oxydation causing any heat. It is not a fair nor permanent oxydation; for blood soon loses its colour out of the body, and within the body it returns very quickly from the extremities of the circulating system into the heart, deprived of all its oxygene. The oxygene seems but slightly attached to the blood; it is not so much united with the blood as conveyed by it; and perhaps it is only when this principle is taken from the blood, and assimilated with the several parts of the body, and fixed among its solids, that it gives out heat. This process of oxydation is intended rather for conveying new properties to the blood than for generating heat, and its chemical changes happen not so much in the lungs as in the extremities of the body.

But allowing it to be a perfect combination, a full oxygenation of the blood, and that this, like every other oxygenation, must give out heat exactly proportioned to the quantity of spoiled air, it is easy to perceive how this heat may be bestowed; for in respiration there is always a generation of fixed air; there is much water formed

formed and discharged in halitus from the lungs; the heat, whatever is evolved, must be divided into three proportions: First, when a part of the oxygene attaches itself to the blood, heat will be evolved, which might be supposed to enter the blood: But, secondly, there is formed in the same moment a quantity of fixed air, which arises from a second portion of the oxygene uniting with the carbon of the blood; and this fixed air requires some proportion of the heat to keep it in its aërial form. Thirdly, a third portion of the oxygene unites itself with the hydrogene or inflammable air, and generates water; this water exhales in steam or halitus from the lungs: and how great a proportion of heat necessary to preserve water in the form of steam, is known to every tyro. Now, to prove that all the heat is expended, not upon the blood, but upon the halitus, or upon the fixed air, we have only to retort their own grand experiment upon the believers in this doctrine, viz. that the breath of an animal communicates the same proportion of heat to water that combustion does; of course none is left to pass into the blood. These philosophers do not mean to say that respiration is as rapid as combustion, or gives out the same quantity of heat in the same spaces; there is not even any two combustions, *i. e.* any two inflammable bodies, which are in this respect alike: they mean, no doubt, to acknowledge the one to be slow and the other rapid; they mean only that the same quantities of air being used in each process, the same quantities of heat will be produced; that one hundred ounces of air being burnt by a taper, and the same quantity of air exhausted by the breathing of

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any animal, the water which surrounds the air, in either case, will be raised to the same temperature, or, if surrounded with ice, the same quantities of ice will be dissolved. But to tell us this, is to tell us nothing; for without knowing the rapidity of the process, we know nothing of the intensity of the heat. Suppose, for example, that one of these philosophers had told us that iron-filings put into water to rust acquire the same quantity of oxygene that iron burnt in the fire does, and, though slowly, gives out the same quantity of heat, because it can acquire no oxygene but what parts with its heat. All this is true; but yet burning and rusting are very different, and so combustion and respiration are. While the vapour which issues from the lungs keeps to the temperature of 96°, and while the lungs and heart do not exceed in heat the rest of the body, there can be little chance of any heat being generated in the lungs, except what is balanced and carried off by the hydrogene and carbonic airs, or by the halitus from the natural secretions of the lungs.

That the animal heat is produced by the action of vessels; that heat does not proceed from the lungs, but is produced in each part of the body—is beautifully proved by what happens in aneurism, where the artery is tied up (in the thigh for example); and where we make, as it were, a great experiment upon animal heat, in the human body itself.

1st. Immediately after the operation, the pulse is stopped, the limb is benumbed, it grows cold, and sinks one or two degrees below the standard of its natural heat. This is the moment of total interruption in the great trunk, and of particular danger. 2dly.

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In a little while the limb begins to grow warm; it swells, and gradually the limb, from being warm only, becomes hot, and the heat rises many degrees above the standard heat of the limb, and above the general heat of the rest of that system to which it belongs. In this second stage there is still no pulse; which proves that the circulation in the great artery is not restored; the heat, swelling, and slight inflammation which possesses the whole limb, plainly proceed from the universal action of all the smaller arteries, for the blood has not yet found out any one artery capable of diluting so far as to carry on the circulation easily, and restore the pulse. 3d. But in the next period the pulse begins to creep; at last it is plainly felt; then it waxes stronger from day to day, till in process of time it beats as vigorously as in the sound limb. Now the blood has forced and dilated some greater artery, the blood flows through the limb, as formerly, in one main channel. The smaller arteries are freed from their load, and cease from their excessive action, and, in exact proportion as the pulse returns, the unnatural heat subsides gradually, till at last it is reduced to the common heat of the body. Thus we may perceive very clearly, that it is while the communication with the system (and with the lungs of course) by the blood-vessels is the most difficult that the heat rises; that when the free communication is restored, it falls; that the intermediate period, in which there is plainly, from the redness and swelling of the limb, an excess of action in all its smaller arteries, is the period of excessive heat; and indeed we may observe, though in a less striking way, the same phenomenon in every inflammation

mation, or, in other terms, in every local disease, viz. the temperature changed, without any apparent dependence on that of the system at large. We perceive in the clearest manner that heat is continually formed in all the extremities of the system; and when we think of the processes which are continually going on in various parts, we cannot but believe that oxygene is completely assimilated, and gives out its heat, not when it is received into the blood, with which it seems so slightly united, but when it is distributed through the body, and assimilated with its parts, of which it forms so important a principle. In the human body various acids are produced; the phosphoric acid; the lithic acid, or that which is excreted by the urine; the acidum pingue, or acid of fat, for fat is a proper oxyd from which this animal acid can be easily obtained. In Ants and other animals peculiar acids are formed: these certainly are direct proofs that the oxygene is deposited from the blood.

But in reflecting upon this most difficult of all subjects, the generation of heat in the living body, many things are to be taken into the calculation, which seem, on the slightest glance, to be far more important than this deposition of oxygene from the blood. It is a law of nature, to which, as far as we know, no exception is found, that a body while it passes from an aërial to a fluid form, or from a fluid to a solid form, gives out heat. Now, what is the whole business of the living system but a continual assimilation of new parts, making them continually pass from a fluid into a solid form? The whole nourishment of the body goes on in the extreme vessels, and

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is a continual assumption of new parts. The extreme vessels are continually employed in forming some acids, which appear naked in the secretions; in forming oxyds, as the fat and the jellies of the membranous and white parts; in the various depositions of muscle, bone, tendon, &c. for these are all continually absorbed, thrown off by the urine and incessantly renewed. They are continually employed in filling all the interstices of the body with a bland fluid or halitus; they are continually employed in forming secretions of various kinds. In performing all this the power of the vessels may do much; but the ultimate effect in each process must be a chemical change, and perpetual changes will produce a constant heat. Place the organ and focus of this animal heat in the centre of the body, and you are embarrassed in a thousand difficulties; allow this heat to arise in each part according to its degree of action, and each part provides for itself.

But how then, some will say, shall this heat be regulated? I say plainly by the heart and lungs. The lungs regulate the stimulant power of the blood, the heart regulates the action of the arteries, in so far as regards the stimulus of fulness and distention; and with these to regulate the centre, nothing can alter the heat of the extremities except partial actions, that is disease.

I will conclude then, that oxygene, if it do communicate heat, does so, "not to the lungs nor to the blood, but to the whole body through the medium of the blood."

## OF THE RESPIRATION OF ANIMALS.

The effects of oxydation then are, to redden the blood, to renew its stimulant power, and to communicate heat, not so much to the blood as to the whole body through the medium of the b ood, and to assist in the secretions and chemical changes which are incessantly going on in all parts of the system. This is accomplished by the perpetual and rapid motion of the blood through the lungs; and there it is exposed to our atmosphere, which is a mixed fluid very different from what we at first conceive, or what our ignorant wishes might desire to have it; not consisting merely of air fit to be breathed, but for the greatest part formed of an air which is most fatal to animal life, whence it has the name of Azotic Gas. Of an hundred measures of atmospheric air, we find twenty-seven only to consist of vital or pure air; seventy-two consist of azotic air as it is called, fatal to animal life; and one measure only is fixed air, which is also an unrespirable air. But of these twenty-seven parts of pure air, seventeen parts only are affected by respiration; so that in respiration we use much less than a fifth part, even of the small quantity of air which we take in at each breath.

The change of the air by respiration is this chiefly; that the quantity is diminished by the abstraction of a part of the vital air; that there is formed a quantity of fixed air, which is generated in the lungs; and that there is discharged along with these a quantity of watery halitus. Therefore atmospheric air, after it has been breathed, is found to have suffered these changes: First, It contains now a considerable proportion

tion of fixed air, which is easily discovered, and even weighed; because when a caustic alkali is exposed to it, the alkali absorbs the fixed air and becomes mild. Secondly, It has less of the vital air, as is easily ascertained by the eudiometer which measures the purity of the whole: And, thirdly, All that remains is merely azotic air, unfit for animal life, or for supporting flame. The oxygene, then, in part unites itself with the blood; in part it forms fixed air by combining with the carbon of the lungs, in part it forms water by combining with the hydrogene of the blood. Respiration frees the blood of two noxious principles, the hydrogene and carbon, the charcoal and the inflammable air: and it insinuates a new principle, viz. the oxygene, into the blood.

Nature has appointed but a small proportion of vital air for our use: our atmosphere is so constituted as to hold but a fourth part of vital air, and of that small proportion one half only is used in the lungs. We see by this how necessary this contamination of our atmosphere is, which seems so unfavourable to life: nature intended that we should breathe slowly a modified atmosphere! With nothing but the purest air to breathe, our life would be quickly consumed, like that deflagration of iron, which is so rapid in vital air, while it burns so moderately and slowly in the common air.

These assistances which we have from chemistry are but a promise of what that science may do; nothing of all that we know concerning the chemistry of the blood is either perfect or sure: we have our

expectations still of seeing things more completely explained; but our expectations are not like those of Mr. Moises, who, in a certain dissertation on the blood, seems so full of his new lessons in chemistry, and so confident of his future atchievements in that science, as to expect that muscular motion shall be very thoroughly explained, and that it will be found to be nothing else, in all the world, but "an explosion of hydrogene and oxygene," and God knows what!—but it is after the manner of "a steam-engine;" and if his scheme holds, they are to be fired off "by means of the nervous electricity of Galvani *!"

## OF THE RESPIRATION OF PLANTS.

But after this view of animal respiration, it is not easy to refrain from saying a few words on the respiration of plants, which bears a relation to animals of infinite importance, and indeed to all nature.

Water has all the appearance of a pure and simple element, but it is in truth a compound body, consisting of two parts; of inflammable air for its basis, and of oxygen combined with it, in that great proportion which the great appetite of inflammable air requires: and as inflammable air, when saturated with oxygen, forms not any acid air, but pure water, it has changed its name, and is now called hydrogen air. When we make water pass through a bed of charcoal, heated to a great degree, the oxygene is seized by the carbon and converted into fixed

* Vide page 236.

air; while the hydrogene of the water is collected in its proper form of inflammable air. When we make water fall drop by drop into a gun-barrel, heated to a high degree, we find that the oxygene calcines the gun-barrel, the inflammable air is collected in the pneumatic apparatus; and the oxygene which has calcined the iron, and the inflammable air which is received in the glass vessels, exactly account for the quantity of water which has been analysed.

Nay, we can carry this process much farther than many of the other delicate processes in chemistry; we can re-compose this water. If we mix in a jar inflammable and pure air, and fire the electric spark through them, water is instantly formed, weighing exactly the quantity of both the airs *. Thus, both by synthesis and analysis, we prove that water is composed of pure and of inflammable air; we find (what it seems difficult to believe, though it was foretold by the great Newton) that water contains an inflammable body; we find, to our great astonishment, while we are regarding the atmosphere which surrounds us as the great magazine of air, that water, where its presence never was suspected, contains an infinitely greater quantity of vital air than the atmosphere; that our atmosphere contains $\frac{27}{100}$ parts only, while water contains $\frac{85}{100}$ of pure air.

* These beautiful experiments were first made in England by Priestley, Warletire, and Cavendish (vide Philosophical Transactions, anno 1784); and when Lavoisier was first told of water being formed by exploding inflammable air, he said it was a thing which he could not believe.

We find this decomposition of water offering new connections, and great views of nature, in all the departments of vegetable and animal life; which, in this place at least, we dare not pursue. How perfectly simple the structure of the most delicate plants and flowers are, may be easily seen in the regularity of those vessels which run through them in one curve or slightly spiral line from root to flower. This simplicity of structure must be presumed from a thousand facts in gardening, very ordinary but very surprising: Parts may be cut from one plant and engrafted on another; slips shoot and thrive, and grafts may be inserted with either end downwards; if with the upper part downwards, still it thrives; the upper part then sends roots into the earth, while that which should have been the root puts forth leaves. It is still a more curious proof of the simple organization of plants, that all the parts of plants, their roots, stalks, leaves, fruit, are all capable of performing the common functions apart: the branches or leaves of plants, if plunged in soil, pump up their sap as usual; even the leaves, strewed upon the surface of water, absorb the water; and if it be impregnated, for example, with fixed air, they absorb the air, decompose it, reserve the carbon, and treasure it up in their own substance, and emit nothing but the purest air.

Many things I must here pass over in silence; as, how plants perform their functions, and assimilate the principles of colour, taste, and smell, only when stimulated and aided by the presence of heat and light; how, when they absorb the atmosphere along

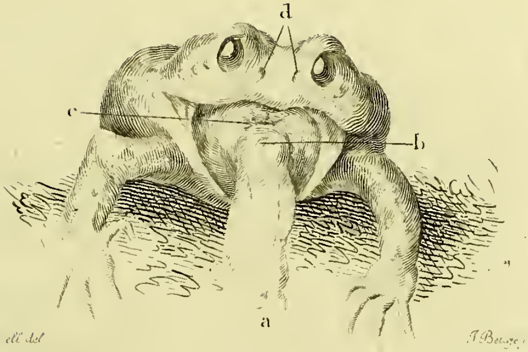
with their other food, they use chiefly the carbonic or mephitic airs, and breathe out the pure air again, or reserve only smaller proportions, in order to form their sweets, and modify their various acids; and fit them for fermentation, by which all their most valuable products are evolved. Nor dare I stay to relate the curious harmony betwixt the airs which they thus absorb, and the aërial acids, spirits, and other products, which fermentation displays.

I have mentioned the simplicity of their organization, only that I might observe once more how perfectly they are nourished by water alone, and how their simple organization converts this apparently simple element into their own substance. For water being absorbed by any plant is decomposed thus: The inflammable air is assumed into the plant, and becomes a part of its substance *: The oxygene is in quantity infinitely too great to be altogether digested or used; the oxygene or vital air therefore exhales from plants in a continual stream; all that air which would poison animals is used by plants, and all the air which animals contaminate plants renew. The freshness of the country, the delights of spring, and all that infusion of health and spirits which we feel in a morning's walk, are now no mystery to us; for at that hour the plants are by the sun and moisture roused from their sleep, and this process is begun. Perhaps there is not in all nature a more beautiful

* Fishes, many of them live entirely on water; and water alone sustains the human body for many weeks under fevers, &c.

harmony

harmony than this, that the foul breath of animals gives life to plants, while the air respired by plants is useful to animals and delightful to man.




## CHAP. III.

### OF RESPIRATION,

OR THE MANNER IN WHICH THE OXYDATION OF THE BLOOD IS ACCOMPLISHED IN VARIOUS ANIMALS AND IN MAN.

THOSE who are the best acquainted with the comparative anatomy, will best know how natural it is for me to illustrate this function, by comparing various animals with man; how pleasant, how useful, it is to know these analogies, every student must feel: and it is now

now full time to correct many mistakes into which modern as well as ancient authors have wandered, from want of general principles, and from want of anatomical knowledge. I shall endeavour to make this chapter interesting and short.

At one time all authors believed that the lungs were moved, not by any external agent, but by some internal power residing in the lungs.

When in their first essays to investigate this subject they opened the thorax, or rather the body, of amphibious animals, they observed that the creature lay out upon the table with expanded lungs; that the lungs continued for hours to appear like inflated bladders; the lungs expanded, the heart playing, the creature quite alive. When they emptied their lungs for them by thrusting tubes down the trachea, or pressing the lungs, the lungs entirely subsided; but in a little while the lungs, at the creature's will, rose again into complete inflation; again they appeared like two tense bladders. Surely, said they, there resides some expansile power in the lungs themselves? But when a few of them began to pursue this mistake with serious experiments, they committed absurdities which should be noticed, for they serve to illustrate the true doctrine concerning the expansion of the lungs.

Mr. Houston, in our Philosophical Transactions, undertook to prove the following things, which, to use the words of a learned author in our university, "are so improbable as to be incredible;" first, That the breathing of a Dog is nothing affected by any wound of the thorax, if only the lungs themselves be not hurt; secondly, That the lungs never collapse, though the

the thorax be laid open; thirdly, That when the breast is entirely laid open, the lungs continue to move, and the thorax also continues to move, but that the motion of the thorax never keeps time with the motions of the lungs. But, to do Houston justice, he endeavoured to explain away the inconsistencies of his own experiments; and the world would never have been troubled any more with them, had it not been for a Mr. Bremond, a great academician, philosopher, and experiment-maker, who published the following suite of experiments in the academy of Paris.

His first mistake is this. "I found (says he) that having stabbed a Dog in one side only, it could run about the house and howl." This is what nobody will doubt. "But also (says he) the air which the Dog took in by the wound when it expired, was pressed out again by the wound when it inspired." This is one cunning stroke of Mr. Bremond; for had the air entered the chest during inspiration, that must have proceeded from the rising of the thorax, which is not the kind of respiration which he wanted to prove; But as the air entered the chest during expiration, it proceeds clearly according to his principles, that the lungs in squeezing out their air have a contractile power; that they contract by their own motion, and leave the ribs, and so make room for the air.

"Next (says Mr. Bremond,) I opened the thorax of a living Dog, and there I saw, that when the lungs contracted the thorax dilated, and when the thorax contracted the lungs dilated."—But, in fact, it means no more than this, that often in these agonies produced by such cruel experiments upon animals, or by actual

wounds in the human body, the diaphragm, chest, every thing which contributes to breathing, is so closely contracted, and the pressure is so great, that the lungs are actually compressed and protruded: so that his seeing, as he says, the lungs dilated, that is, squeezed out, when the thorax contracted, is like the ignorance of a child looking from a carriage-window, who believes and wonders at the trees and houses running backwards. But as no experiment-maker ever allows his experiments to remain incomplete, Mr. Bremond finishes his by the following daring assertion, "that always when he made his incision no more than three inches long, the lungs dilated themselves with so much violence that they drove out the air before them, protruded themselves through the opening, and made the blood jerk out at all points*." In short, he repeats this mistake in every possible form, viz. that the motions of the lungs and thorax are directly opposite to each other; that the lungs are contracting while the thorax dilates, and the thorax contracting again when the lungs dilate. When I open a Frog, it fills its lungs with perfect ease after both its breast and belly have been entirely cut away. "If admitting air into the thorax could really make the lungs collapse, why do not those of the Frog collapse?". This is such gross ignorance as should not have been endured in one reading papers before the

* If one word of this were true, what would become of those who had adhesions of the lungs? Surely if the lungs and thorax moved in opposite directions, the one contracting while the other dilated, the force of the lungs never could pull down the thorax.— Such patients must die.

Royal

Royal Academy of France. He is farther back in physiology than Oligerius, Jacobæus, or Malpighi.—The Frog has a respiration peculiar to itself, or at least to its kind.

## FIRST SPECIES OF RESPIRATION, VIZ. BY A DIAPHRAGM.

Under this title I shall explain the respiration of Man, and of animals like Man; which have heavy lungs, of a strong fleshy texture, a prodigious number of blood-vessels passing through them, their lungs lodged entirely in the chest, and their respiration performed by a diaphragm.—I mean to arrange respiration according to the mechanism of those organs by which it is performed; and place in the first order that of Man, and animals which in this point resemble Man; and I say respiration by a diaphragm, for this is indeed the only use of a diaphragm. The support of the great blood vessels, the compression of the viscera, the expulsion of the urine and fœces, the ridding the womb of its burden; all could have been performed by the pressure of the abdominal muscles alone! the diaphragm is added merely for breathing.

Forsaking, for a moment, authority and minute anatomy, let us explain it in the shortest and most intelligible way.—The diaphragm divides the thorax from the abdomen; it is strong, muscular, and acts with great power, enlarging the thorax; it is convex towards the breast, and concave towards the belly: when it acts, the belly is protruded, the diaphragm becomes flat, the thorax is enlarged, and a vacuum would

would be formed, but that instantly the lungs follow it and prevent a vacuum; for the lungs are free in the thorax, the air has free access to go down into the vesicles of the lungs; and so when the diaphragm retires, the lungs follow it, being dilated by the pressure of the air which enters by the trachea.

But this protrusion of the belly excites the abdominal muscles to react; their pressure restores the diaphragm to its natural form; when pressed back again by the abdominal viscera, it rises in the thorax, becomes again convex towards the lungs, the thorax is reduced in size, the lungs are compressed, and that air is driven out again which they had just received. The thorax also moves in concert with the diaphragm: and this motion is most curiously arranged; for, first, the intercostal muscles lift the thorax for respiration, in the very moment in which the diaphragm is pressing down, and consequently at the instant when the abdominal muscles, which are attached to the lower borders of the thorax, are relaxed, so that they suffer it to rise. Next, the thorax is to be compressed and pulled down by the abdominal muscles; and this happens at the very instant in which the abdominal muscles react against the diaphragm; so that the abdominal muscles, while they thrust back the diaphragm, pull the lower edges of the thorax down with great power.

Thus in Man, and almost all animals, the respiration is performed by a diaphragm.

## SECOND SPECIES OF RESPIRATION, VIZ. THAT OF BIRDS.

Birds are supposed to breathe like Man, but have in fact no diaphragm to divide their body; they have vesicles, or air bags extending through the whole body, and connected with the true lungs; their sternum and ribs expand over the whole, and by their motion move the air vesicles, which blow the air through the true lungs; while the true lungs, far from having any thing to do with a diaphragm, never move.

Every one skilled either in anatomy or physiology must know, that one of the greatest physiologists of our times has written a long paper about the respiration of birds, little understood, and in proportion much admired; of which function he is so thoroughly ignorant, as to explain how they breathe with a diaphragm; and until I set this point right, my arrangement is good for nothing.

"The diaphragm of fowls (says Mr. Hunter,) is thin, transparent, and membranous, and runs across the abdomen." But if thin, membranous, and transparent, it can perform none of the functions of a diaphragm, and must be merely such a membranous interseptum as some Amphibiæ and Reptiles have, supporting the viscera, or confining them in their place. But he thinks to make good his point by acknowledging the imperfection of this diaphragm; and adding, that it is moved by certain small muscles, which arise from the inner surface of the ribs, and pull the diaphragm and lungs down. He still persists in calling it a diaphragm

in the very sentence in which he informs us that "it is perforated in many places with holes of a considerable size." Since Mr. Hunter is so bold as to say of other authors, that they have too limited notions of a diaphragm, we may be allowed to say, that his notions of it are as much too liberal as theirs are too confined. But descriptions and arguments of this kind, where the author is entirely wrong, should not be tediously refuted, nor answered in any other way than by a simple statement of the case*.

The anatomy of a fowl's respiratory organs is plainly this.—The trachea having descended into the thorax, divides into two branches; of which one goes in a simple and ordinary manner into each side of the lungs. The heart, which lies immediately upon this division of the trachea, sends into the lungs two great pulmonic arteries, and receives in return two veins. The lungs themselves are very small, dense, and bloody; they are somewhat of the shape

* For the respiration of birds, *i. e.* for raising and depressing the thorax, I see many muscles having a very strong analogy with those of Man. The pectoral muscles are amazingly strong, and their scapulas absolutely fixed, so that these could raise the breast with great power; but I suspect that no such power is needed, that the elasticity merely of the sternum and ribs raises them. There lies under these, upon the back, a very strong muscle like our serratus posticus. There lies on the inside of the ribs a set of three beautiful muscles like large intercostals; they are quite insulated from all other parts, are seen instantly upon opening the belly: these are what Mr. Hunter calls Muscles of the Diaphragm; but in truth the breast of a bird is pulled down strongly by its short yet strong abdominal muscles, and rises again by its own elasticity with little help; and these are merely intercostal muscles.

of the human lungs; they are seated in the very uppermost part of the chest, are closely braced down to the back, and are indeed in part niched in among the ribs, which in birds have their edges very deep. These are the true lungs for oxydating the blood; they never move; the air passes through them in the following way.

These lungs cannot move, because they are braced down by a membrane very thin, and cobweb-like, yet very strong. This membrane is a peritoneum, lining at once the whole thorax and abdomen (which still are not parted from each other), and it is a covering to the lungs, liver, and other viscera; but also the same cobweb-like membrane forms cells, which fill the whole cavity from the neck down to the anus, and from the breast-bone to the back; and which are so attached to all the surfaces, being, as I have said the lining membrane, that as the breast moves these cells must move.

These cells appear at first sight quite irregular; and Mr. Hunter gives but an idle description of them along with that of the septum, which he calls the diaphragm: But I hold it as a principle, that, although we may not see it, yet all is orderly in the animal body; in fact the order of these cells is extremely regular: First, there is a membrane which comes down from the breast-bone in a perpendicular direction till it touches the viscera; it runs the whole length of this common cavity of breast and abdomen; it enters into the great cleft of the liver, and so divides the liver into two lobes, serving as a ligament for the liver, as a mediastinum to divide the

great

great cavity into two, and also as a sort of root or basis for the cells of either side: though beautifully transparent, it is very strong. At the upper end of this mediastinum touches the heart, and there expands into a very large bag exquisitely transparent, which is at once an air-cell and a large pericardium. Next, at its lower end, it touches the gizzard, or stomach, and forms a large cell surrounding it. Behind the liver, which fills all the upper part of this great cavity, and the gizzard which fills all the lower part, lie all the intestines, which are also surrounded with many cells: at the sides of the cavity is occupied by three or four large cells extending from the middle membrane to the flanks of the bird. And, lastly, when we look into those greater cells which are nearest the lungs, we see clearly many openings, very large, oblique, running flat under that part of the membrane which braces down the lungs, so as to communicate the air from the lungs to all the cells very freely.

Now let me add, in one word, that the essential parts of respiration are these: First, There is no diaphragm, no division of breast and belly, the stomach lying upon the rectum in the pelvis; a true and muscular diaphragm could not exist in birds, having nothing to do in their scheme of respiration. Secondly, The true lungs are small, high in the back, quite immoveable, so that no diaphragm nor no power of vacuum could unfold them; and these lungs are perforated at every point, so that they could not expand by air. Thirdly, What has been confounded with the true lungs is the vast congeries of abdominal cells, which are of use only in lightening the creature that it may

may fly, and in forcing the air through the true lungs. Fourthly, There is in the place of a divided abdomen and thorax, with long abdominal muscles, no proper abdomen, a long thorax, a high sternum, and very elastic ribs, extending along the whole body till they almost meet the pelvis, making the abdominal muscles very short; and the air-cells all along adhere to the inner surface of these bones.

With these points clearly before us, we cannot mistake the mode of respiration in birds. The thorax does the whole; the thorax is raised, and immediately the cells are expanded, by which two functions are performed; for the air which comes into the cells, passing through the lungs, oxydates the blood, and the cells become full at the same time so as to make the body lighter. The thorax is depressed again, and the air, which passes now a second time through the lungs, may a second time oxydate the blood, for it is not thoroughly spoiled; and what is spoiled is diluted with the air of many cells, which respiration cannot empty at one stroke.

The final cause also is plain. Had the lungs in a fowl been solid and fleshy as they are in fowls, (or even in any other creature,) and at the same time sufficiently large to perform, without the help of those air bags, all the functions of lungs, they must have been large and heavy in proportion to the body of the fowl; they must have occupied much room, and added much to the weight. But the lungs of a fowl are very dense, very small in proportion to its system, very full of blood, quite fixed, and undilatable; the rapid course of the air through them backwards and forwards enabling them in their business of oxygenation to do much

with

with little. In short, there are two functions to be performed in birds: First, the oxydation of the blood, which is performed by the small, fleshy, contracted lungs, which lie immoveable in the upper part of the thorax, and through which the air blows continually as through a furnace, while they are quite passive: and, secondly, The lightening of their bodies for flying*, which is performed by the abdominal cells; and the confounding of the abdominal cells with the true lungs, and the describing of a diaphragm where none can be, was like to have put us all wrong †.

* Although I say the lightening the bird for flying, I do not mean to affirm absolutely, that it is either for flying, that they are made light; for I have given, on the contrary, an example in a bird which seldom flies, viz. the common fowl; and I have added a plan of the Ostrich's cells, which is a swift footed bird, and never flies: nor do I even affirm, that it is for the sake of lightness that these cells are thus provided. Perhaps one chief use is blowing through the true lungs to oxygenate the blood; yet I should think lightness were a chief use, for the cells are far too large for this office alone of ventilating the lungs: and they are so diffused as to enter even into the bones of fowls, where the air is so freely admitted, that if you break a bone which has such an air cell in it, for example the shoulder-bone of a fowl, you produce an emphysema.

† Plans of the Respiration of Birds.

In the first Plan is seen—(*a*) The treachea dividing into branches—(*b*) The heart sending great pulmonic arteries to the lungs—(*c*) The true lungs shaped like the human, but exceedingly small, dense, and bloody—(*d.*) The thin and delicate membrane, which forms a mediastinum—(*e*) The great air cell in which the heart lay—(*f*) The cell where the stomach lay—(1, 2, 3, 4, 5) A number of cells, very large, which surround all the viscera, and fill the whole abdomen—(6, 6,) Two large cells which lie nearest the true lungs—(*gg*) The true lungs, which lie close to the back-bone.---At ( *i i* ) is seen on each

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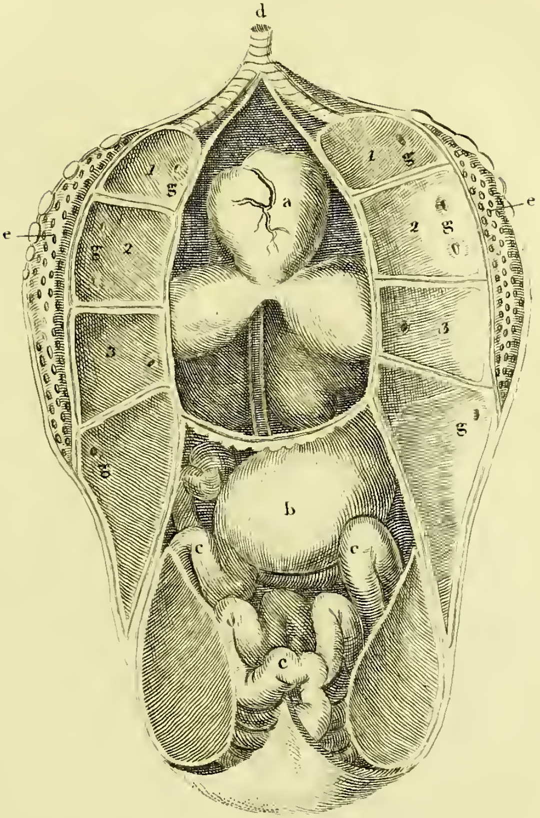
I Bell sculp

The Ostrich's Lungs
drawn by the Parisian dissectors




a The Heart lodged in one great Air Cell b the Stomach and c the Intestines surrounded by other great Cells. d the trachea branching towards the lungs. e e The true lungs firm fleshy very small & fixed down to the backbone. 1 2 3 other great Air-Cells in immediate contact with the Lungs & communicating with all the other Cells. the holes g g g &c are the openings by wh the Cells communicate with the Lungs & with one another.

## THIRD SPECIES OF RESPIRATION, VIZ. THAT OF AMPHIBIA.

This species of respiration differs from the two first in these respects; it differs from the respiration of Man, because there is no diaphragm; it differs from that of birds, for there is no chest covering the lungs: There is a short sternum, no chest, no ribs by which the lungs may be moved, there is no vacuum formed in their respiration; they fill the lungs by the working of their jaws, or, in other words, they swallow their air just as we swallow our food.

The Frog, the Newt, the Chamelion, the Tortoise, and many other creatures, breathe in this way; and as one of the most curious mechanisms for respiration, I shall represent that of the Frog. I have placed at the beginning and end of this chapter two drawings, in which their organs of respiration are seen; for, as I have just explained, their organs of respiration are not in the belly, nor in the lungs themselves, but in

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each side one of the many holes by which the true lungs give out their air to the abdominal vesicles. Figure 2d shows the manner of their respiration; for the air-vesicles are seen again (1, 2, 3,)—filling the whole abdomen. The true lungs are seen at *(a)*—lying close by the spine, and as high as the root of the neck; and the length of the sternum and ribs, which are marked *(b, c, d,* &c.)—show that the fowl is all chest, and that every time the chest rises to the line *(hhh)*—the vesicles are dilated, and the air passes through the lungs in the direction *(i)*—and every time the breast is pulled down by the abdominal muscles, which are marked *(k)*—the air is driven out again through the lungs in the direction *(m)*,—the lungs being all the while motionless, and passive merely.

the mouth. At (*a*) is seen its tongue of prodigious length; it is not like the tongue of any other creature, hinged far back in the mouth, but is fixed in the chin to increase its length, while at the further end it is forked. We see it saunching out this monstrous tongue in catching flies; perhaps also with this it rakes mud. At (*b*), behind the root of the tongue, is the slit-like opening of the trachea; this is what is called the glottis in the human subject. We see this rima opening and gasping for air when we keep the mouth thus distended; it has no epiglottis or valve to defend it; its own contraction is sufficient, for when closed you cannot even guess at its place; besides, the jaws force down the air into it, and the long tongue carries the food over it into the gullet. At (*c*) is seen the opening of the gullet, which when dilated is as wide as its jaws; it looks more like the stomach opening directly into the throat; and this great width requires a very strong muscle to contract it, and makes a great circle of rugæ. At (*d*) is seen the most important part of all, the nostril of the Frog, with which it continually breathes, never opening its mouth.

Looking carelessly upon this creature, we do not perceive that it ever breathes, for it lies plunged over the mouth in water. It is never seen to open its mouth; there is no motion in its sides like breathing; in short it does not seem to breathe; and when it is provoked, (or rather through fear), though it still keeps its mouth closely shut, its sides and back rise, and it blows itself up apparently by some internal power. But when we observe the creature more narrowly, we perceive that there is a frequent motion of its jaws, or rather

of

of that skinny and bag-like part of its mouth which covers the lower jaw. We are apt now to fall into a worse mistake, for this bag under the jaw is alternately dilated and contracted, the mouth is never opened to take in new air; the creature seems to live all the while upon one mouthful of air, and seems to be playing it backwards and forwards betwixt its mouth and its lungs.

But, lastly, when we observe its nostrils, we find that there is in the nostrils a twirling motion for each movement of the jaws, which makes the whole process perfectly simple to our comprehension; for a Frog breathes by the nostril alone, it cannot breathe by the mouth; it never raises its mouth above water, nor opens it but to catch flies or other food. If you keep its mouth open, you see it presently struggling for breath; for its respiration goes on in the following way: Its broad jaws are continually shut; they lock into each other by grooves; the mouth is completely close, and forms a sort of bellows, of which the nostrils are the air-holes, and the muscles of the jaws which come from the os hyoides draw in the draught by their alternate contraction and relaxation; and the nostrils lie so obliquely over the hole in the skull, which is represented at (*a*) in the Plate at the end of this chapter, that the least motion of them enables them to perform the office of a valve. First there is a twirl of the nostril which lets in the air; then a dilatation of the bag under the jaws, by which the mouth is greatly enlarged and filled with air; then a second motion of that bag, by which the mouth is emptied and the lungs filled; then there is a slight motion of

the sides of the creature, by which the muscles of the abdomen expel the air again; and then the twirl of the nostril and the motion of the jaw succeeds again: so that with these creatures inspiration is the swallowing of the air by their broad expanded jaws, with their coverings driving it down into the lungs; and expiration is the contraction of the abdominal muscles driving it out again; and these two motions, when we observe a Frog attentively, are as perfectly regular as respiration in a man. Their muscles of respiration are not the muscles of the belly but the muscles of the jaws; and this causes the uncouth broadness of the jaws in Frogs, Newts, Lizards, Serpents, Turtles, &c.

Now we shall no longer wonder why the Frog never opens its mouth; why it never seems to breathe; why, after opening its belly, the lungs still project; why, after emptying its lungs, it can fill them again at will, not by any peculiar power in the lungs, but by blowing them up with its jaws. If you gag the Frog and keep its mouth open, it cannot fill them, because it cannot breathe; if you plug its nostrils, it suffocates, though not soon; if you keep its mouth open by force, you soon find it struggling for breath; and looking into its throat, you see the glottis opening from time to time*.

The Newt (or as it is called in this country, the Ask) breathes with the jaws and nostril like the

* Dr. Monro in his explanation of Plate 16. shows us very obligingly the diaphragm of a Frog, marked *(c)*.—This diaphragm is mentioned a second time in explaining the same Plate.

Frog;

Frog; it has, like the Frog, a constant motion by short strokes of the bag under the jaw (which bag is formed by the membranes of the mouth, covered and moved by the genio-hyoidei and mylo-hyoidei muscles); but we observe that every minute, or less, it stops as if intending some particular motion; then gradually the bag swells out under the lower jaw to a great size; then the air contained in it is puffed down into the lungs with a sudden flap of the bag; and in proportion as the jaws are emptied the long sides of the creature are heaved up.

The Toad, the Chamelion, the Green Lizard, breathe exactly in the same way. The Chamelion has the flat broad jaws of the Frog; they lock into each other, and it never opens its mouth; it swallows its air in mouthfuls, drives it downwards into its lungs; its lungs are of a vast extent, stretching from the jaws all along the abdomen: it is the vast size of its lungs, almost concealing the abdominal viscera, that makes Gesner say, "that of the entrails of a Chamelion the lungs only are visible." The air it swallows in greater or smaller quantity as its needs or fears prompt it. When you alarm this timorous animal, it fills its sides just as a Frog swells out its back; and either in this greater respiration, or in its ordinary breathing, we see it pressing the air onwards from cell to cell; and we see the motion proceeding from its jaws to its breast, and all along its sides, till its lank form is quite puffed up almost to bursting.

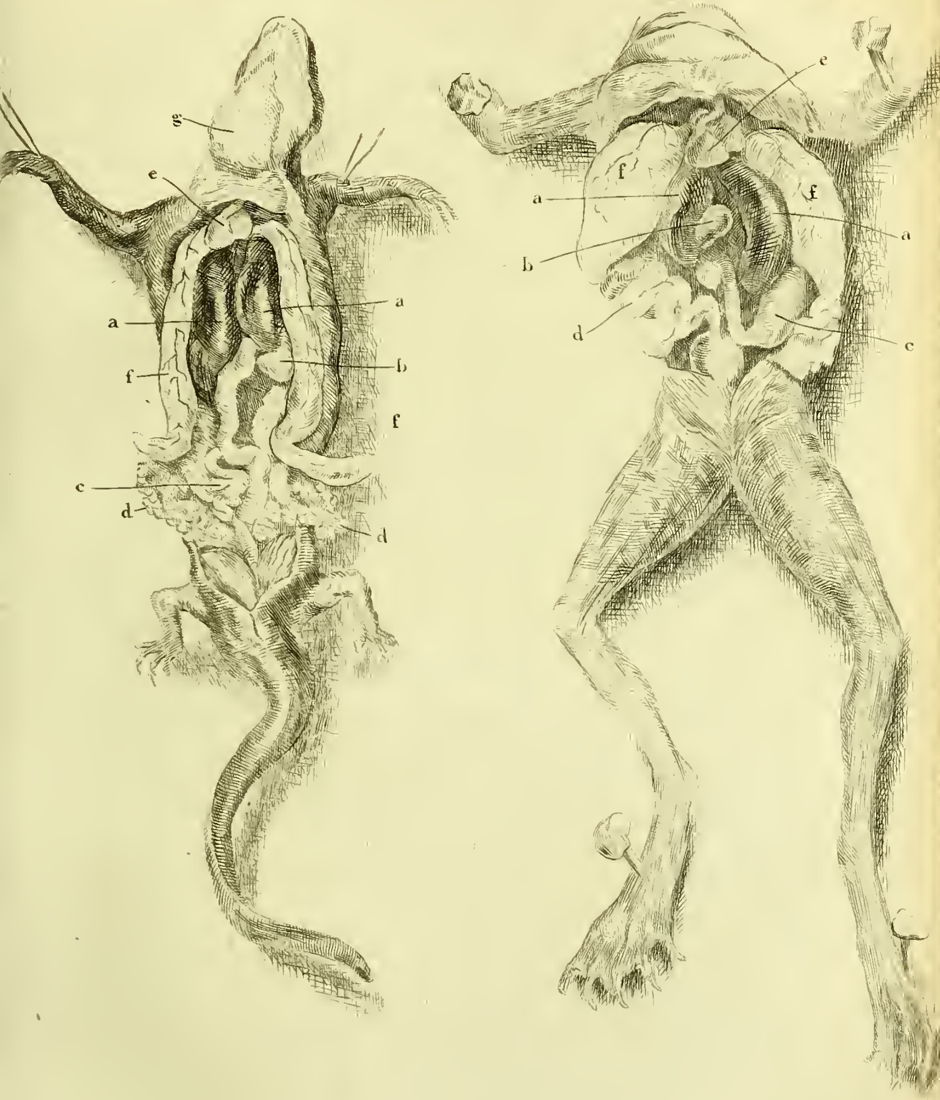
All these creatures have, in addition to their peculiar respiration, a peculiar kind of lungs, thin, membranous, and extremely delicate: the lungs even of

so great an animal as the Crocodile are, when inflated, very delicate and transparent, of a rose-colour or slight red, consisting of delicate vesicles, and exactly like the Frog's lungs. The lungs of the Frog are in shape like a fir cone, with the stalk of the cone on each side fixed to the side of the heart. But these conical lungs of each side are delicate, silvery, perfectly transparent, divided within into innumerable cells like a honeycomb; and these also are so extremely delicate, that though the outside membrane is as transparent as a soap-bubble, the divisions can hardly be seen, except by inflating and drying the lungs, and then cutting them. The lungs of the Ask are still more beautiful, as a specimen of what are called membranous lungs; for the creature is very long in the body, its lungs run down along all its sides; they are about the size of a common earth-worm or writing quill; they end like a blind gut; they are of a bluish white, exquisitely transparent, like the swimming bladder of a fish.

It is the nature of membranous lungs to oxygenate but a very small quantity of blood; they are membranous, only because there is not that vast profusion of arteries, veins, and strong vesicles, which there is in the human lungs. The pulmonic artery and vein are always, in the membranous lungs, extremely small in proportion to the vast system which they serve. There cannot be better examples of this fact than these two drawings of a Frog and of a Newt: In the Frog is seen the small artery and vein spreading more suddenly over the lungs; in the Ask is seen the same artery and vein, running down more directly,

and

Neut Frog



In the Frog aa is the Liver b the Spleen c the Stomach
d the Intestines e the Heart ff its conical vesicular Lungs
In the Neut a the Liver b the Stomach c the Intestines
d Ova in the Ovariæ or Egg-beds e the Heart ff Thin vesi
cular Lungs which are long like Intestines & transparent
like the swimming bladder of a Fish g the Bag of the
Jaws by which the Lungs are blown up

and for a greater length along its worm-like lungs: in both we see the artery to be little bigger than the ranular arteries of the Frog's tongue at the head of the chapter. The manner of its coming off from the aorta is seen in the first plan in the book, where figure 2. represents truly the Frog's heart; and there we may observe how small a proportion the pulmonic artery bears to the rest of the arterial system.

From these peculiarities of the membranous lungs, it is plain that the oxydation of the blood is a process of small importance in their system, that this process being of little value with them, they are the better enabled to go into the water, and to want breath for a time. But chiefly it appears, that the meaning of this peculiarity is not so much to give them the privilege of Amphibiæ, in allowing them to go into the water; for many creatures, as the Chamelion, all the tribe of Lizards, Newts, Toads, Serpents, &c. have these lungs, and yet never approach the water: but that the chief use of it is to establish in this class of animals a peculiar constitution, a permanent, almost inexhaustible, irritability, and a tenaciousness of life; which, I believe, no creature, whether of the land or the water, wants, which has membranous lungs. And when we are told that these creatures can be kept two days under water, as a proof of their being Amphibiæ, I cannot but consider it as a very childish proof; for, in the first place, we see them breathing with wonderful regularity when out of the water; when plunged into the water, we see them very soon struggling for breath! and if they can live for two days without air, it is only because they could

bear any other kind of injury with equal ease, and could live two days without their heart or their head.

FOURTH SPECIES OF RESPIRATION, VIZ. THAT OF FISHES.

In this species of respiration the creature breathes neither water nor air, but water mixed with air, and this office is performed by gills in place of lungs.

The reason why I have called this a species of respiration, needs to be very fully explained; for, though little observed, it is a certain fact, that a creature, without any apparent change upon its system, can do well, having its blood oxygenated at one time by gills, at another time by lungs. The Frog, for example, lives long in the water; while it does so, it may be considered as a fœtus which cannot breathe: the young frog which has not yet acquired its proper and natural respiration, breathes like a fish. For the first fourteen days after hatching from the egg, and while the Tadpole is very small, it has gills, which are two long, projecting, fimbriated appendages like fins; by the thirty-sixth day these appendages are taken into the jaws, and form four rows of gills on each side, regular, and like those of a fish; but at the same time, this fœtus has its lungs within the body, not to be used till it come out into the air, when the lungs assume their function and the gills shrink. The same system in this instance, which was at first served by gills, is in the end oxygenated by lungs.

The motion of the gills in fishes is a true and perfect respiration: for, in the first place, if there be no air

air in the water, or not enough of air, they cannot breath; distilled water is to a fish what the vacuum of an air-pump, is to a breathing creature: if you exhaust water with an air-pump, if you boil it, if you distil it, if in any way you deprive it of its air, fishes cannot breathe in it, but come up to the surface and gasp for air. If you take a fish out into the air, it is the same with plunging any breathing creature into water, it gasps and dies. Fishes cannot breathe in air wanting water, for that element is not accommodated to their species of lungs; nor in water wanting air, for then there is no oxygene; and we find, upon extracting the air from water which fishes have breathed, that it is contaminated, exactly in the same way with air which had been breathed by any breathing animal, that it differs very little from that in which a candle has burnt out. This is the reason that when many small fishes are inclosed in a narrow glass, they all struggle for the uppermost place, and that when in winter a fish-pond is entirely frozen over, you must break holes for the fishes, not that they may come and feed, but that they may come and breathe; without this, if the pond be small, they must die.

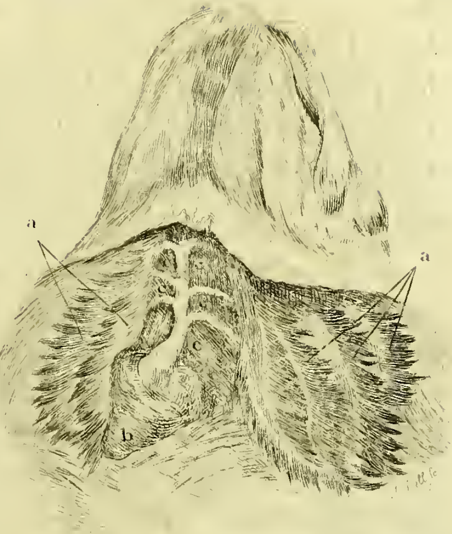
In the respiration of fishes, there are two curious points to be considered: First, The manner in which their respiration is performed; and secondly, The manner in which their blood, when thus oxydated, is distributed over the body.

The red part or gills, which serve as lungs, lie under a broad scale, which defends them from all extraneous bodies, or hurt, or pressure of any kind, for they

they are exquisitely delicate. Their respiration is like the Frog's in this respect, that they swallow the water with their mouths; and in this it is like the fowls, that they drive it through among their gills, which lie perfectly passive like the true lungs of a fowl.

A fish's gills are ranged in semicircles under the great flap which covers them four or five semicircles on each side; the fish opens its mouth wide, fills it with water, shuts the mouth, then drives the water backwards, so that it lifts the great flap and makes its way out behind, and rushes with a sort of stream through among the red gills, raising each semicircle from another, and making the water play freely round each feathery-like process. It seems to me, that wherever this mixture of water and air is used, there must be some force to give impression to the air upon the blood. The depth to which fishes go, and the pressure of the water, must give some effect in impressing the air upon the lungs. The gill must play more or less strongly according to various depths, just as the fish must swim more strongly against a ruder stream. Some fishes, as the Trout, Perch, Salmon, Herring, have more open gills, yet they do not want this power of impressing the air more or less strongly against the gills. The Eel and the

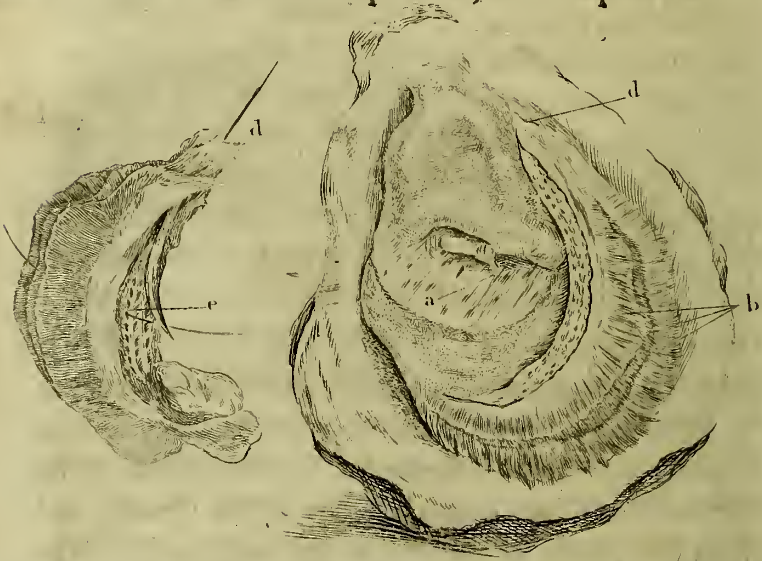
the flat fishes, as the Skate, have their gills more concealed. They swallow the air by the mouth, and breathe it out by holes in their side. The shell fishes give the most curious example (and none more singular than the oyster) of very regular and beautiful gills; and therefore I have given two




a. a. Gills of a Trout — b. Its Heart
c. c. the Arteries of the Gills

slight marginal drawings; the first of which shows the heart and lungs at (*a*)—The heart, which may be seen beating about 40 in a minute at (*b*)—The whole of the gills as they lie out upon the side of the Oyster, and bear a very large proportion to its body, at (*c*)—The canal, partly opened, in which the water passes to the gills from the mouth (*d*)—And at (*e*, figure 2.) is seen, separated from the body, a long canal opened; before it was laid open, it was somewhat of a triangular figure within; it constitutes the basis of all the circles of gills; it contains the most beautiful ranges of holes that can be seen in nature, by which, as is very plain, the water is admitted to each feather of each gill. The fish swallows the water by its mouth, which is at (*d*, figure 1.)—drives it down into this great canal, and so out again. It is by this, I am persuaded, that merely the soaking of a fish's gills in water would not do, for they might have lain abroad, as indeed

indeed they do, and soaked very securely in a shell-fish; but the water must be applied with a degree of force proportioned to the condition of the lungs, or the needs of the system; and every fish, whatever be the mechanism of its respiration, has this power.




Having explained this first point, viz. the mechanism of their gills, I proceed next to explain the circulation of their blood, how their blood is oxydated, and how it is distributed over the body.

A fish and an amphibious animal have both of them the simple heart, consisting of one auricle and ventricle, but with this singular variety, that the Frog, for example, wants the heart belonging to the lungs, a small artery only from the common system performing the office; while the fish again wants the heart, which should circulate the blood through the body; and has that heart only which belongs to the lungs. The whole blood of the fish passes through this

this single heart, and therefore the whole mass circulates, parcel by parcel, through the gills, for every time that it circulates through the body. We shall begin its circulation, then, at the heart. First, The whole blood of the body is returned into the heart of a Skate, for example, by two great veins (*aa*)—These two great veins deliver it into a vast auricle, or reservoir rather, which lies over the heart (*b b*)—The auricle delivers it into a strong ventricle (*c*)—whose action is further strengthened by the action of its aorta, which from the heart up to (*d*),—where the valves are, is very muscular and powerful, and constitutes, in a manner, a part of the heart. But this great vessel must in this species of circulation change its name, for it really is not an aorta, has nothing to do with the body: both the heart of a fish, and this its only vessel, belong entirely to the lungs or gills, and as these are called the bronchiæ, this is the bronchial artery. The gills of this fish are five in number on each side, and on each side the bronchial artery gives out two branches (*e* and *f*)—which serve the five gills:—(*e*) the lower branch is large, and serves the three lower gills—(*f*) the higher branch, which goes off like one of the arms of a cross, serves the two upper gills.

Secondly, These arteries being distributed along the gills, divide into exquisitely small branches producing that feathery appearance which is so beautiful. Those minute subdivisions of the bronchial vessels expose the blood to the air. This may explain to us how in the human lungs the exposing of the blood, even with the interposition of membranes and of the arterial

arterial coats, may be sufficient for the oxydation of the blood. All the blood thus oxygenated is returned by veins, corresponding exactly in number and arrangement with their arteries; and the heart being turned aside, as in figure 2. and all the other viscera taken out, the veins are seen accompanying their arteries and emerging from the gills at (*g g g*)—and they are seen at (*h*—to form the aorta.

Thirdly, The aorta (*i*)—is formed by the veins of the gills, and the veins of the gills lie close upon the skull of the fish, and the aorta upon the back-bone; and this vessel is in one sense a vein, since it is a continuation of those veins which return the blood of the gills; but both in office and form it is a true aorta; in office, because it distributes blood to the whole body; and in form, because it no sooner swells out into the shape of an aorta than its coats grow hard, strong, muscular, fit for its office, while those of the veins from which it is formed are pellucid, delicate, and very tender. The aorta is full of the oxydated blood of the gills; and although, by the delicate circulation of the gills, it has lost all communication with the heart, it circulates this oxydated blood through the body to all the muscles, glands, viscera, &c. without the intervention of a new heart.

The veins which return the blood of this aorta are the ordinary veins; they arrive in two great branches at the heart, and need not b furt her explained.

I will not be at the trouble to repeat the tedious calculations of authors concerning the immense surface which the gills expose: Let the student look to the gills, and he will presently, with the help of this short

short sketch, understand how the whole function goes on.

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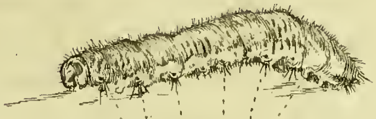



FIFTH SPECIES OF RESPIRATION,

VIZ. THAT OF INSECTS.

There is in this kind of respiration no breathing organ like the lungs, but tracheas or air-tubes by which air enters into all parts of their body.

What is most perplexing in this species of respiration is the prodigious quantity of air which these creatures receive; the little connection betwixt the air-tubes and the heart; the impossibility of tracing blood-vessels from the heart to the various parts to nourish them; and the clearness with which we see their air-tubes branching over all parts of their body. The stomach, bowels, and other viscera, the legs and wings, even the very scales of insects, have branches of the air-tubes dividing over their surfaces like the delicate vessels of leaves and flowers. In short, the magnitude of these air-tubes is quite surprising; and their branchings are so minute, delicate, universal over all the body, that it looks almost as if the air-tube had exchanged functions with the heart and arteries.

It

It is plain by these expressions of admiration that I do not mean to attempt so difficult a subject as this at present: I only mention difficulties which it is surprising that others have not declared and investigated, for nothing can be more interesting. The little that we do know shall be simply and plainly told.

The forms of insects are often very strange, their lives very irregular, sometimes in water, sometimes in air; many of them begin in Worms, and end their lives as Flies and Moths; and according to these varieties of their form, or life, or generation, their air-tubes are various.

Sometimes, as in the common Bee, they have nearly the form of lungs: They begin like two bags, resembling those of the Alga Marina, or sea-weed, in shape; and these bags distribute pulmonary tubes, with occasional bag-like dilatations in the course of the tubes, through all the body. More commonly the air-tubes of insects are direct tubes, mere tracheas, of a very singular construction; they have rings like the tracheas of animals; they have a delicate membrane covering these rings and forming them into a tube: the tube continues always rigid like a flexible catheter, or other tube of twisted wire not liable to collapse: They begin by many open mouths opening along the sides of the insect, and they terminate in myriads of vessels, which, in their forms and progress over the various parts of the body, resemble blood-vessels more than it is easy to conceive. These air-tubes being thus rigid, are always full of air, and by their refractions through the transparent parts of the insect's body they give it in the microscope a great degree of brilliancy;

liancy; as for example in the Louse, whose air-tubes make the brilliant lines and points which are contrasted like a silvery colour with the dark and opaque parts; or in the Mite, which is as beautiful in the microscope as the Louse; and when the larger insects are prepared by drying and varnishing, and preserved in turpentine, the air-tubes are beautiful. Of these curious particulars, the openings of the air-tubes are best seen in the Worm from which the common Butterfly is produced; we count these holes down the sides one, two, three; we name them puncta respiratoria, spiracula, or most commonly stigmata: (Vide figure 1.) Their transparency and brillancy is well understood from the view of the microscopic Louse, (figure 2.) That particular form in which they resemble more the lungs of animals is seen in the pulmonic bags (*a a*)—and the tracheas or air-tubes (*bb*)—of the common Bee, (figure 3.) Their exquisite branchings through the various parts are well seen in the drawing of the air-tubes which run along the wings of a Bee (figure 4.), or those which twist and ramify





round

round the intestines and stomach of a Worm; and it is not to be forgotten, that though the beginnings of these tubes in their great tracheas and near the puncta respiratoria are quite transparent, their extreme branches are beautifully white like vessels filled with chyle, or rather one might be apt to mistake them for nerves.


*Fig. 3*

*Fig. 4*

Of the way in which this function is performed, there must be more varieties than we can know or comprehend: this we may safely conclude from the little that we do know, finding the variety so very great.

Almost all insects have their puncta, like those of the Caterpillar, ranged along the side, and inosculating like those of the Louse from branch to branch: often the puncta open along the sides; but in place of inosculating from branch to branch, all round one side, they inosculate across the belly, the one side communicating with the other. This is best observed in the small Worm from which the Bee proceeds (vide Fig. 6.), which is a magnified drawing of the Bee-worm. And here it must be observed, that, as in other insects, always the stigmata or breathing points correspond neatly with the folds or rings while it continues a Worm, and with the scales or divisions of the body when it becomes a Fly; in the Bee-worm also the inosculations answer to the flexures or joints of the body.

Often

Often when the insect lives in water, it has only two puncta respiratoria: these puncta begin either in the snout or in the tail; they are the openings of two great air-tubes which run down each side of the insect like two aortas, and the insect has means of rising to the surface, takes down a bubble of air along with it, and discharges a bubble of air before it rises again: of this nature are the air tubes of that Worm from which the Ephemeris proceeds. The sketch of the Ephemeris and its air-tubes is given in figure 7.—This Fly has but two spiracula; they are so small towards the neck, where their commencement is, that their mouths cannot be easily found. The two great air-tubes (*a a*) are seen like two aortas running all along the body, and their minuter branches (*b b*) are seen ramifying beautifully upon the abdominal muscles and other parts. Many insects are aquatic when first they are hatched from the egg. They have little gills which serve them while they continue in the water, as, for example, the Ephemeris Fly; but along with these gills they have the ordinary structure of air-tubes, and the day on which they emerge from the water, the gills shrink, and the air-tubes begin their function; and these changes succeed each other very rapidly in all insects, but most especially in the Ephemeris, which is destined to live but one day.

It is most of all singular, that in some insects the number of respiratory points, or puncta, changes according to the various conditions or stages of their existence. For example, a Worm which crawls among the dust, since it must breathe less easily, has more puncta than when it has changed its state to that of

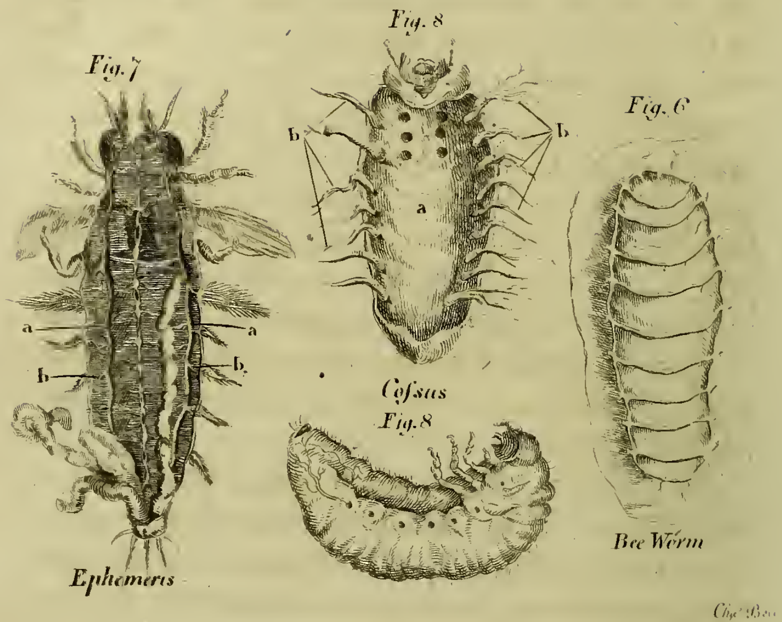
 a Fly

a Fly, and has its puncta very freely exposed to the air: in the Rhinoceros Beetle the Worm has more puncta respiratoria, and closer, because it crawls on the ground amidst mud or dust; they are less numerous in the Fly, as its air-holes are always more freely exposed; and when the Beetle is actually flying, those puncta which were closed by the cases of the wings are fully opened; so that the insect breathes more freely, and perhaps its body is lightened, so that it flies more easily: it is also particular, that in the full grown Beetle, though the puncta be less in number, the lungs are enlarged, they both change their form and become more capacious; for the tubes are mere tracheas or straight lines, with direct branches in the Worm, but in the Beetle they are dilated from point to point into air-bags.

Insects in general are bred in eggs, transformed into Worms, assume then the form of an aurelia, that is, of a Fly, small but full formed, with its legs drawn up, its wings plaited and folded, ready at all points to burst from the covering which surrounds it; for both in posture and in the membranes which surround it, it resembles a fœtus. In these three stages it still is nourished by air-tubes: they open by puncta respiratoria while it remains a Worm; the same puncta still serve it while it is wrapped up an aurelia or concealed Fly; when the Fly bursts out, the same puncta, the same tubes, which have served in its former stages, serve it still; only this is most curious, that when from a Worm it proceeds a Fly, the skin which it rids itself of (crawling out of it and pushing with its feet) carries off along with it many of the internal

internal parts; the mouth, the anus, and especially all the respiratory tubes, lose an internal skin, at the same time that the old skin or slough is pushed off from the outward surface of the body; and when the puncta are thus changed, they are left more open than before, and often their number is changed. For the drawing of this slough or skin (*a*)—from which the Worm has just disengaged itself, and the old air-tubes (*b*)—inverted, and adhering to the cast skin, see figure 8. which is the figure of the Cossus, an affected name by which Mouffet and others have chosen to distinguish the Worm from which the Horned Beetle proceeds.

These are the various ways by which insects are supplied with air; and nothing can be more interesting than to observe the vast proportion of air which they draw in, as if they lived upon that element; the infinite care with which Nature has guarded this main function in insects, ordaining so many various ways by which they may in some sense fill their system with air. The variety of ways is changed, and suited, as I have observed, to their various ways of life, and to the various conditions and stages of their life; while they are Worms, when they are involved fœtuses, and when they have burst their shell and are full grown. In short, Worms, Aureliæ, Flies, Beetles, Bees, and all forms of insects, have all of them their tracheas by which they breathe a wonderfully large proportion of air.



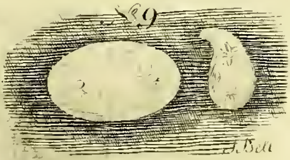

There can be no mistake concerning the function of their air-tubes and of their heart; it is ignorance or inattention only that can cause confusion: the heart of a Caterpillar, of a Snail; of the Worms from which various Flies are produced, are seen distinctly through their transparent body, running down their back in form of a tube, sometimes slightly oval, sometimes having frequent dilatations, always throbbing with distinct and equal strokes.

Nor can there be any mistake that it is air they breathe; for before we dissect an insect, we must kill it; the contortions of a live Caterpillar prevent all deliberate dissection, or even a view of the parts; we may poison the insect, as with turpentine or spirits; we commonly drown it: this is done by immersing it

in

in a little tepid water. Nay, we find a thing which is at first inconceivable to be really true, that notwithstanding the inosculations of the air-tubes with each other, which seems to provide against all such effects, when we close up the stigmata of an insect one by one, the parts become in the same proportion paralytic; if we varnish over the stigmata of one side, that side becomes paralytic; if we varnish over the stigmata of both sides up to the last holes, the insect lives, but in a very languid condition, it survives in a kind of lethargic state for two days, without any pulsation in its heart; if we also stop the two highest holes, it dies.

Of all the examples of respiration, that which is reported by Spallanzani is what I most wonder at, and cannot but doubt. In acescent liquors, or the juices of animal bodies, animalcules are seen plainly with simple glasses, moving sometimes rapidly, sometimes slowly; but never hitherto has any author pretended to see their lungs or heart. Mr. Spallanzani says, "that these animalcules are elliptic bodies; that in the centre of each ellipsis he sees two stars, which are in constant alternate and regular

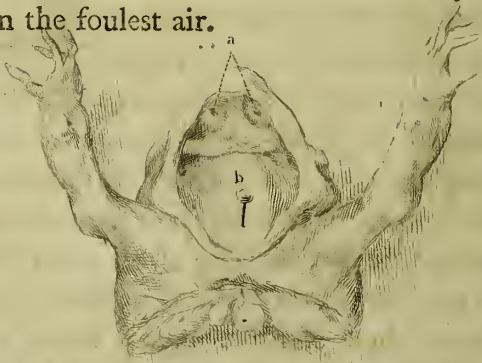


motion, whether the creature rests or moves. Each star-like body has in its centre a small globe, and every three or four seconds the globules are blown up slowly to three or four times their natural size, and as slowly compressed again; and every time that the radii are inflated the central globule subsides. On one side of these star-like bodies there is an oval part, which is continually agitated with a trembling motion; he calls the star-like bodies lungs, and the oval

body he thinks is the heart." Spallanzani surely has forgotten that he is speaking of lungs in an aquatic insect: if these star-like bodies have any such use, they must be gills.

These are the animalcules which Buffon called organi germs, and from which, as materials and pieces, he built up the animal body. But if all this be true, then the day is come which he little expected, when the organic particles, on the faith of which he built all his system of generation, are proved to be living and moving animalcules, voracious of food, devouring each other, breathing air, and having a visible pulsating heart; animalcules deposited from the atmosphere, and generating like other insects of their kind.

Thus we are convinced of the importance of respiration, and the absorption of air in all living creatures, from Man even to the meanest reptile; and not least needful in the last and lowest order, which receive in proportion a fuller supply of air than fishes, amphibiæ, or Man; one point chiefly confounds the little knowledge that we have on this subject, viz. that many insects live best in the foulest air.




a the Nostrils — b the Tongue

Plans of the Diaphragm

No. 1

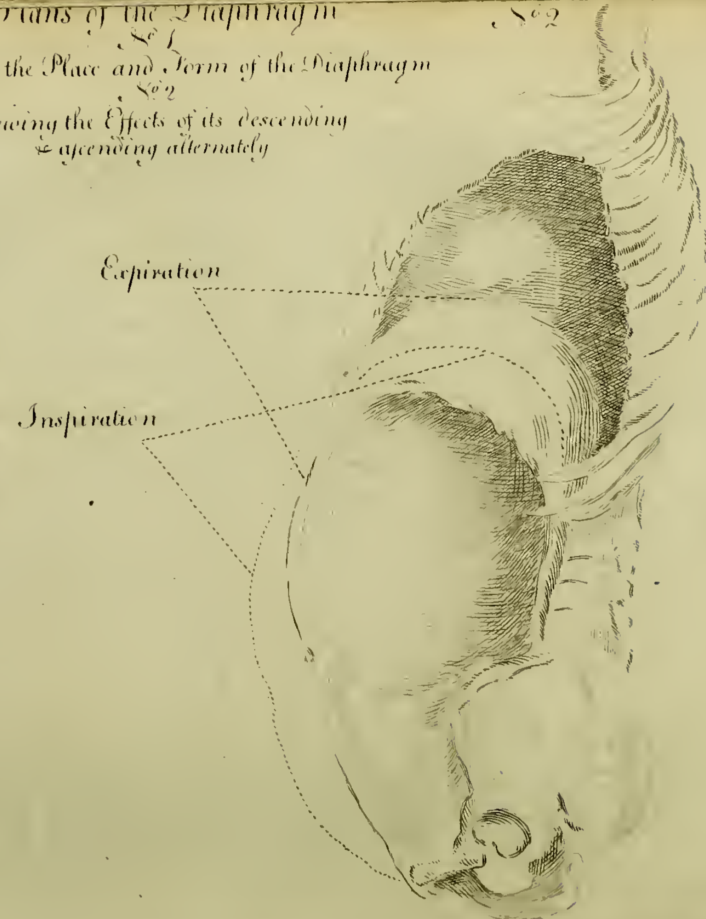
Shewing the Place and Form of the Diaphragm

No. 2

Shewing the Effects of its descending & ascending alternately

No. 1

No. 2




Bell del.

Cha. Bev. f.

## CHAP. IV.

### OF THE PECULIARITIES IN THE CIRCULATION OF THE FŒTUS.

THE peculiarities of the fœtus all relate to the oxydation of the blood, and are such chiefly as fulfil the circulation of the blood without any need of its passing through the lungs, enabling the fœtus to live without that function in its mother's womb.

1. We are assured that the blood which comes to the fœtus through the umbilical vein is pure, or of greater value than that which the fœtus returns to the mother's system. Either this blood is restored to all its properties merely by passing through the mother's system, and what is thus drained off from the extremities of the mother's system is more than sufficient for the life of the child; or, without such direct communication, the placenta performs to the fœtus a function equivalent to that of the lungs. Then this blood, whose value and properties must be lost, if pushed through the circulation of the liver, passes only in part through the liver, while a chief share of it goes by a side passage, which is called the DUCTUS OR CANALIS VENOSUS, under the liver, directly to the heart*.

* N. B. The canalis venosus is marked in the plan.

2. This

2. This blood does not pass through the circulation of the lungs; perhaps it ought not to pass; for there being no respiration, no air admitted to the lungs, the blood might rather be contaminated; perhaps it cannot pass, the lungs never having been expanded with air: but, however that be, there is a side passage for conveying it from the right to the left side of the heart clear of the lungs. For this use is the FORAMEN OVALE, which is an opening of no inconsiderable size betwixt the right and left auricle of the heart; its area is as large as that of the vena cava; and it is sufficient, without the help of the ductus arteriosus, to convey the blood freely from right to left.

3. The DUCTUS ARTERIOSUS serves quite another purpose; for though the circulation of the aorta is well maintained in the adult body by the force of one ventricle only, yet in the fœtus one ventricle will not suffice. In the fœtus the heart must push its blood not only through that system of vessels which is within the body, but also it must push it onwards through a second circle of vessels, viz. those of the placenta; for the iliac arteries do not descend into the thigh and pelvis of the fœtus, but the iliac artery itself, with little diminution (very small branches only being given downwards into the pelvis and thigh), turns upwards along the side of the bladder; and these two arteries going out from the navel, form the umbilical cord; and the heart of the fœtus has to give life and action not only to its own internal system, but to these two arteries comprehending the chief bulk of the aorta, which run out to the distance of three feet along the umbilical cord, and which make wonderful convolutions

convolutions in the placenta, and terminate with extreme minuteness upon its surface. It is this which occasions the necessity of the ductus arteriosus, which is merely a union or inosculation of the pulmonic artery with the aorta. This union is formed by a great branch of the pulmonic artery in the fœtus, joining the aorta below its curve. This great branch (for it is greater than the two branches which go to the lungs) is named the ductus arteriosus, and may be defined an inosculation betwixt the pulmonic artery and the aorta, so very large, that it gives the aorta of the fœtus twice its natural size and proportion, and enables the blood of that artery to have the full force of both ventricles; of the left ventricle through the aorta, and of the right ventricle through the ductus arteriosus by one synchronous stroke.

4. The contaminated blood of the fœtus must be returned to the mother, or at least to the placenta; for which purpose the two iliac arteries are reflected along the side of the bladder as I have just explained. I say the iliac arteries without reserve, because the hypogastric and femoral arteries, that is, the arteries of the pelvis and thigh, though they are the largest branches of all the body in the adult, are in the fœtus, extremely small; and thence that smallness of the lower extremities compared with the largeness of the head, which characterizes the child, and which it takes years to redress.

## DUCTUS VENOSUS.

Thus have I defined these parts and their uses, in order that their strict anatomy may be the more easily

easily explained; and the part first mentioned, viz. the ductus venosus, is the part the most difficult to be understood, and never without the help of a plan. In my plan I have endeavoured to elucidate these points.

First, The mere anatomy, connections, and inosculations of the vessels; showing how the umbilical vein brings in the blood of the mother; how that vein spreads in the liver and feeds all its left side with blood; and how the ductus venosus carries part of that blood away from the circulation of the liver, conducting it directly onwards to the right side of the heart.

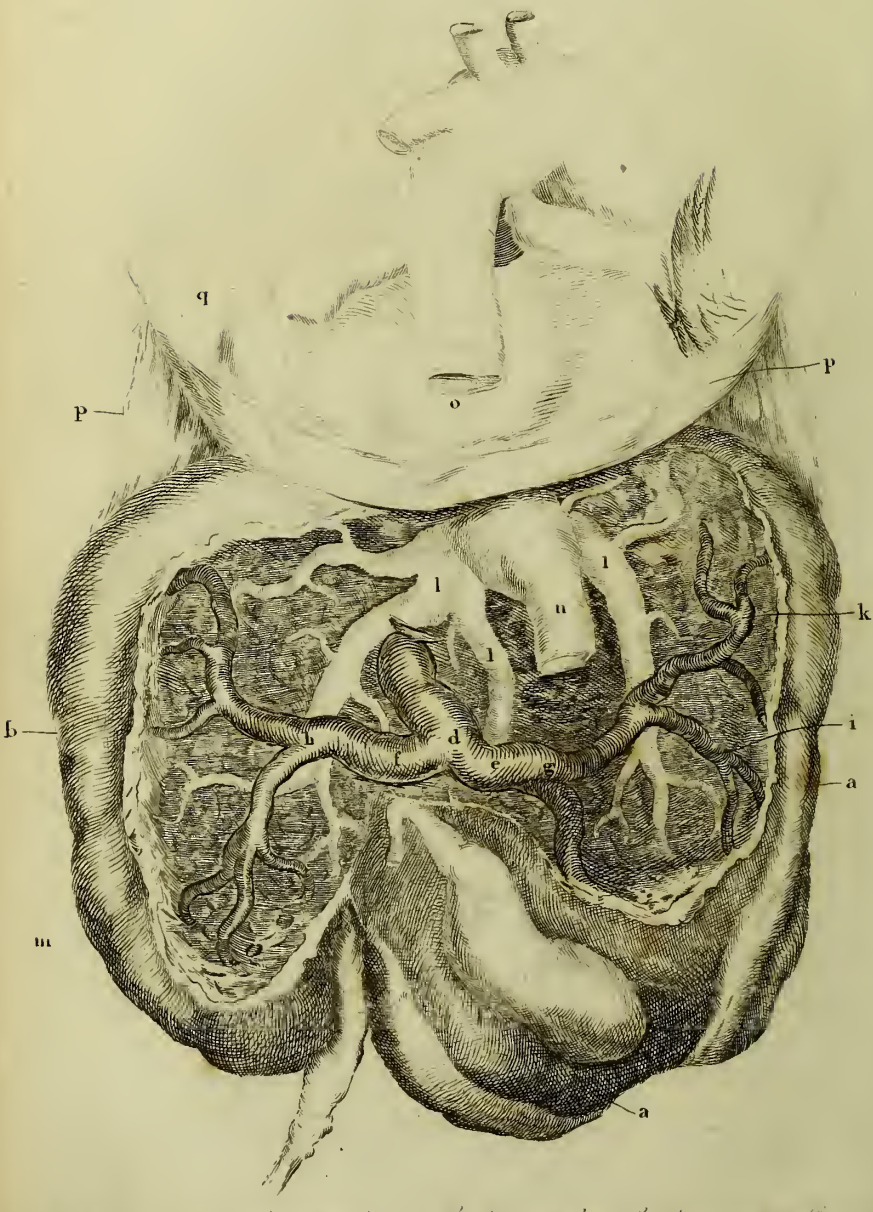
Secondly, I have endeavoured to explain what parts of the liver each branch supplies, and how these vessels lie in the liver of a new-born child.

Thirdly, I have contrasted with this the change of form in these same vessels, when, as happens in the adult, the form of the liver is changed, and the ductus venosus and the umbilical vein are obliterated, and gone or converted into ligaments of very trivial use or size.

The blood from the maternal system transmitted through the placenta, and oxydated, or having undergone some change equivalent to oxydation, comes down along the umbilical vein:—the vein enters by the navel, adheres to the inner surface of the abdomen, enters into the liver at the top of that great transverse cleft which divides the liver into two lobes; and after entering the liver, it begins, as if it were the

regular

Third Plan of the Liver




n is the Vena Cava Abdominalis o is the place where the Cava enters the right
. Auricle p is the Diaphragm upon which the right Auricle lies and the heart &
arteries are seen above the Diaphragm q being the apex of the heart

Fig. 2

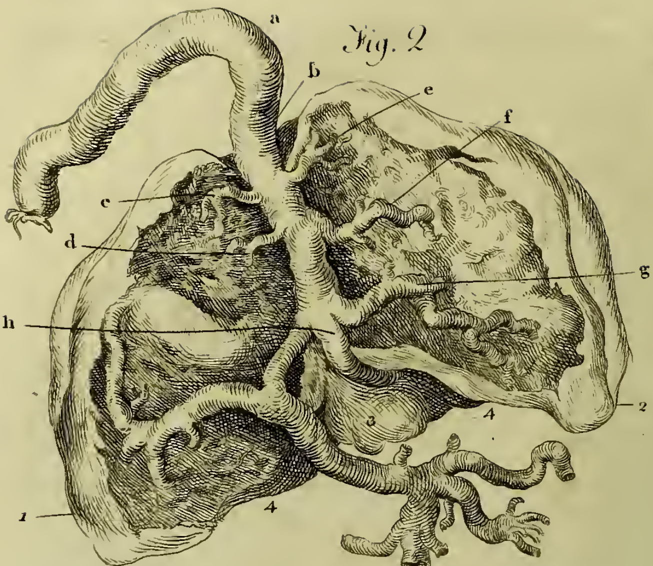
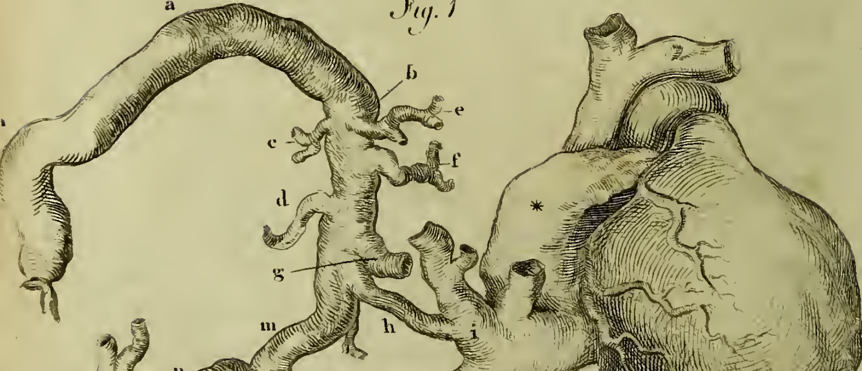



Fig. 1



regular and peculiar vessel of the liver, to distribute branches through its substance from right to left.

In figure 1.—(*aa*) shows the umbilical vein—(*b*) the point at which it enters the liver—(*c, d, e, f,*) branches given to the substance of the liver, till at last it gives off (*g*)— a very great branch, which is indeed the chief trunk for the left side of the liver; it branches out in the liver like the opposite trunk, (*m*)—But I cut it off short, lest it should confuse the plan. Next comes (*h*)—the ductus venosus, whose office is important, but whose size is not quite what we should suppose. It comes off direct from the umbilical vein; its course is short, and a little curved; it joins at (*i*)—the largest of the hepatic veins, *i. e.* of those great veins which return the blood from the liver, and along with it goes directly into the right auricle of the heart, which is marked (*).—This, perhaps, might suffice as a description of the ductus venosus; but it is convenient and will make a clear subject, to finish that circulation of which this ductus venosus is one of the chief difficulties.

This I consider as the end of the umbilical vein, for here its circulation ends: or, if it sends blood into the right branch of the vena portæ, its proportion is but small. But the VENA PORTÆ (which is just the collection of all the abdominal veins into one trunk,—of the splenic vein (1)—of the mesenteric vein (2,)—of the hemorrhoidal vein, *i. e.* the vein from the pelvis (3);—the vena portæ, I say, composed of all these veins, is the true vein of the liver.

The branches of the vena portæ are gathered into a trunk at (*k*)—that trunk enters the liver at (*l*)—it divides

divides into two great transverse branches at (*m*) and (*n*)—the one serving the right side of the liver and the other the left; but in the fœtus this left branch (*n*) is not known as the limb or left branch of the vena portæ, but looks rather like the right branch of the umbilical vein; indeed, it is named so by Mr. Bertin.

But that I may not convey vague uncertain notions of vessels apart from the organ which they are to supply, I have in figure 2. laid these vessels upon an outline of the liver; by which I am sure to explain correctly, 1. How the umbilical vein (*a*) enters at (*b*) into that great longitudinal cleft which parts the liver into two lobes. 2. How it begins, as if it were the peculiar vessel of the liver, to distribute its branches (*c*, *d*, *e*, *f*,) from right to left. 3. How the last great branch (*g*) of the umbilical vein is the left trunk for supplying the left side of the liver with blood. 4. How the ductus venosus (*h*) goes off in the most direct manner from the umbilical vein, and the fairest for receiving its full proportion of blood; and how it carries that blood directly onwards to the back of the liver, or that part which touches the diaphragm, and there the ductus venosus enters the heart*.

* The lobes of the liver in figure 2. are marked thus:—(1) The great right lobe—(2) The great left lobe—(3) The little lobe, or Lobulus Spigelii, lying betwixt them; and it should be remembered, with regard to the position of the liver in this drawing, that it stands upright, as if pulled up by pulling at the umbilical vein (*a*)—or at the round ligament, which is the same thing (for the vein is converted into this ligament), so as to bring it into a perpendicular posture, and show the back line of the liver (4, 4,)—where it touches the spine and diaphragm.

But

But my third plan explains the adult liver as if these branches had never existed. The two first plans show what are its veins in the fœtus. This third plan shows what are its proper and permanent veins; for those peculiar veins which we find in the child are accommodations for the fœtus, are ranked among the peculiarities of the fœtus, and are, when the child is born obliterated by a new circulation; and what is very curious, by a circulation which goes through the same vessels in a retrograde course.

In this third plan I represent the liver of the adult; I consider only the vena portæ, which is its proper vein, and I give the vein and the liver itself a new and more simple form. This plan is drawn from an adult liver, most of its substance being dissected away.—(*a*) Marks the right lobe—(*b*) the left—(*c*) the Lobulus Spigelii. These are sufficient to mark the more important points, and I have not spared the substance of the liver in other parts where vessels were to be shown.—(*d*) Is the shape of the vena portæ tied after injection, and cut short and twisted a little so as to make it stand almost perpendicularly—(*e*) and (*f*) are the two great lateral branches going to the right and left sides of the liver; and this cylindrical part of this very great vein is called the sinus of the vena portæ. It is so formal, lies so fairly at right angles with the vena portæ, goes so regularly into two equal limbs, the branches too, even when spreading in the liver, are so formal, that it looks more like a piece of human mechanism than any thing belonging to the living body: it appears so here, not from the stiff and awkward

ward forms which a plan must have, but because it is thus in nature. The right branch (*g*) is distributed very formally to the right side of the liver :—(*h*) The opposite branch is distributed as formally to the left; and there is no mark or note by which it can be known that this left branch had ever proceeded from the umbilical vein, or been filled by it, or been any thing but what it now appears, the left branch of the vena portæ corresponding most regularly with the right. And in the same way it may be observed, that the middle veins of the liver (*i*, *k*, *l*, *m*,) are now plainly known to be legitimate branches of the vena portæ, though they appeared in the fœtus to be proper branches of the umbilical vein: they are named so by Bertin and others, the best anatomists; but that they are plainly not so, because the umbilical vein (since these branches go off at an angle) filled them only by a backward course, while here in the adult they are filled by their natural trunk, the vena portæ, in a more natural way.

Now, by glancing the eye from the circulation of the fœtus to that of the adult, we observe these changes: First, The liver of the fœtus has blood circulating in two directions; the right side of the liver is filled from the vena portæ, the left side by the umbilical vein. The liver of the fœtus having two veins has a large quantity of blood, a growth larger than that of any of the viscera; and indeed the liver alone seems to fill all the upper region of the abdomen. This is changed when the child is born; the umbilical circulation is cut off and the liver of the child ceases to grow but in proportion to the other

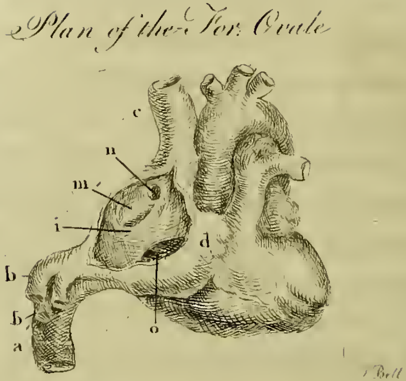
parts.

parts*. Next, we observe in the fœtus how the umbilical vein runs into the left branch of the vena portæ, insomuch, that the left branch of the portæ has not any determined form; nor has the sinus venæ portæ, or the horizontal shaft of this vein, that peculiar and formal shape which I have already observed. This shape, then, of the sinus venæ portæ, is not to be looked for in the child, and is not found in these plans.

Again, we find in the adult those blood-vessels obliterated which served such peculiar uses in the fœtus; the blood which flowed formerly into all the left side of the liver by the umbilical vein now comes along the venæ portæ; these veins are now working their blood forwards in a retrograde course; the blood which flowed once in the direction (*i*) N° 2. runs now in the direction (*k*) N° 3.

In this plan are seen also the hepatic veins, or branches of the vena cava, in the liver. These three great veins marked (*l l l*)—are the returning veins, which carry back to the heart that blood which the venæ portæ (assuming the office of an artery) circulates in the liver; and it is with one of these that the ductus venosus joins before it enters the heart.

* One is forced to speak this unphilosophical language, though the size of the liver in the fœtus is as just and well proportioned to the fœtus, as that of an adult body is to an adult body.




FORAMEN OVALE.

THE foramen ovale, the second peculiarity of the fœtus, is a hole of no inconsiderable size, transmitting the blood freely from the right to the left side of the heart. Its use is obvious, even from a general view of the system; and when we look more closely into its mechanism, its uses are completely explained. Its valve being placed on the side of the left auricle, perfectly settles (and that by the only authentic proof) the course of its blood: and, satisfied with the description which I am now to give, I decline all dis-

EXPLANATION of the PLAN of the FORAMEN OVALE.

(*a*) The ascending cava, with its hepatic branches (*b b*)—(*c*) The descending cava.—(*d*) The right auricle, where it lies against the roots of the aorta and of the pulmonic artery—(*i*) The isthmus Veussenii, as it is called, or circle which surrounds the oval hole—(*m*) The valve of the foramen ovale—(*n*) A small opening, which we always find towards its upper part—(*o*) The opening towards the ventricle.—This plan is intended chiefly for showing the true place of the foramen ovale; its anatomy and just form is better represented in the true drawing which ends this subject.

putes

putes about the nature of this opening, or its valve. This is a subject which disputes may perplex, but cannot explain. Another reason which I have for declining such controversies, is this: It is an easy matter to impose upon a whole academy, easier by far than upon one ingenious man: and thus it came to pass that in the French Academy each theorist brought dissections of the heart and foramen ovale suited to his own doctrines; each, when convenient, changed his ground a little, and brought new dissections; and thus valves and auricles, fœtal and adult hearts, double Cats and human monsters, made their annual exhibitions in the halls of the French Academy: the Society never sickened nor tired, and the raree-show lasted exactly one hundred years.

What kind of doctrines were current at such a time it is almost superfluous to explain; yet I think it not amiss to remark two examples, of obduracy on the one hand, and of ingenuity on the other, in two of the greatest men. Mr. Mery had conceived notions about the circulation of the blood in the fœtus, which can hardly be explained*; but it was one point essential to his doctrine, that the blood in the fœtus moved directly from the left auricle to the right. He was forced to deny that the foramen ovale had a

* All that can be done towards the explaining it in one word is this: He "fancied that the right cavity of the heart was so large, and the left so small, that always the left side was obliged to disgorge again upon the right side; and this was the meaning of the blood rushing through the foramen ovale from the left side to the right."

valve; and this doctrine he continued, with many quirks and tricks, to maintain to his dying day. Mr. Winslow agreed with Mery; he said, that the foramen ovale had no valve; that though it had a membrane, that membrane performed nothing of the office of a valve; that the blood passed freely from right to left, or from left to right, as occasion required; that thus the two auricles were as one. He forgot for a time that there is but little circulation in the fœtal lungs; that the right auricle is filled with all the blood of the body, while the left is filled very sparingly by the pulmonic veins. From these data it is plain, that the balance must always be in favour of the right auricle; that it always must be more full of blood; that without some valve the blood must rush with a continual pressure from right to left; while, again, the place of the valve is itself a demonstration that the blood cannot pass from left to right. Winslow, when he some years after perceived that he had spoken idly upon this subject, left Mr. Mery among his foolish arguments and dissections, and retracted all that he had written with a manliness of spirit which deserves to be recorded.

The foramen ovale, is not strictly oval, but is rather round. In the plan it appears oval, because there I have endeavoured to represent the condition of the vessels when the heart is dilated and the vessels full; but when we lay it out for demonstration or for drawing, it appears, as in the drawing, of a rounded shape.

The oval hole is in the partition betwixt the two auricles at its very backmost point; for, in fact, the auricles

auricles touch each other only behind; at their fore part they are separated by the roots of the aorta and pulmonic artery, as may be seen in any of the plans. We look, then, for the foramen ovale at the very backmost part of the right auricle; or rather it is placed so high in the auricle as to seem to belong rather to the root of the cava descendens.—A ring rises round the borders of the hole, very prominent, and exactly like the ring of the meatus auditorius internus in a child.—This was named ISTHMUS VIEUSSENII; but this conceited name of isthmus, which Veussens gave it, is quite unintelligible, and it must be changed for that of the CIRCULUS FORAMINIS OVALIS, the ring or circle of the oval hole.—This circle is thick at its edges; very strongly muscular, like the musculi pectinati of the auricle; in so much that authors of some character have thought this a sphincter for the oval hole. There is no doubt a kind of decussation of the fibres at each end of the oval hole; so that these fibres, forming a sort of pillar on each side or edge of the foramen, the name of Pillars of the Ring, or COLUMNÆ FORAMINIS OVALIS, is less exceptionable; though these pillars, or any thing deserving such a name, will not be easily found by one beginning anatomy.

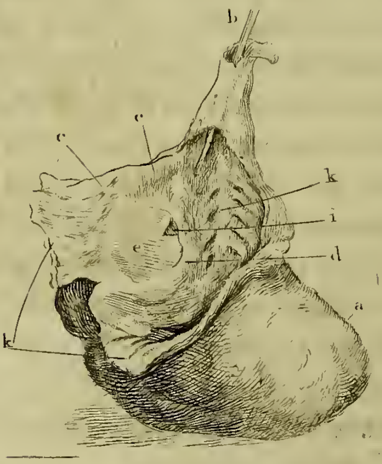
The valve of the oval hole lies entirely on the left side, as the round edges of the right side may demonstrate. By taking the blunt probe, we find we can lift it towards the left side; but being pushed towards the right side, it rises into a sort of bag, and opposes the probe. The valve is perfectly transparent; it seems delicate, like all the other membranous valves, but is

 really

really strong. There is often left, after the closing of the valve, a small opening at its upper part. The valve closes soon after birth: the hole is so large, that this membrane forms a very large share of the partition betwixt the auricles; its transparency is such, compared with the rest of the walls, that it is as distinct in a boy, or in an adult, as in a fœtus.

This is the anatomy of the oval hole, and of its valve; and this proves, and any one who examines it will entirely be convinced, that the blood of the fœtus passes through it from right to left*.

*True Drawing of the Foramen Ovale.*



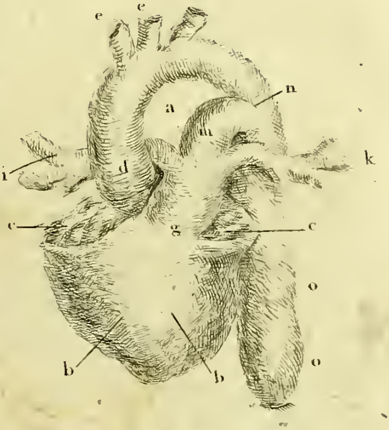

* This heart of a fœtus had all its parts cut away, except the ventricles (*a a*)—the vena cava, with a blow-pipe in it (*b*)—and the wall or partition betwixt the auricles (*c c*)—which is here unfolded, to show the foramen ovale. The musculi pectenati, or muscular fibres of the auricle, are well seen at (*k k*).—(*d*) Is the circle of the valve, the annulus foraminis ovalis.—(*e*) Is the valve itself.—(*i*) Is the small opening in the upper part of the valve, where the valve falls slack, and ready to open.—(*m*) Is one of the tricuspid valves, or of those valves

## DUCTUS ARTERIOSUS.

The ductus arteriosus I have defined a great inosculation betwixt the pulmonic artery and the aorta; not for the purpose of conveying away that blood which should pass through the lungs, but for giving to the blood of the aorta the propelling power of both ventricles: and how well it is able to perform this office will be easily seen from the drawing on my margin†.

The pulmonic artery of the adult divides, as has been marked in all my former plans into two great arteries, one going to the right side, another to the left; but in the fœtus there arises a middle branch betwixt these two. It is larger than both put together; it is in the middle, and so comes most directly from the heart; it goes in a

*Ductus Arteriosus*



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valves which guard the right auricle; and both this and the valve of the foramen ovale appears so bright against the blackness of the heart, because they are transparent, and the light is made to shine through them, which is the best way of demonstrating the valve of the foramen ovale.

† This sketch is taken from a little preparation made on purpose, where a quill was thrust in so strongly bewixt the ductus arteriosus and aorta, as to separate them unnaturally, and leave a space (*a*) betwixt them.—(*bb*) Marks the two ventricles—(*cc*) the place from which

straight line towards the aorta, and joins with it immediately below the arch. This is the ductus arteriosus, the centre branch of the three branches into which the pulmonic artery of the fœtus is divided. It is bigger than the aorta in the fœtus; it gives the full force of the right ventricle to the blood of the aorta, in addition to that of the left. In the adult it is so thoroughly obliterated, that by the most careful dissection we can show no other vestige of it than a cord-like adhesion of the aorta and pulmonic artery.

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These, then, are the chief peculiarities of the fœtus*; but the conclusions which have been drawn from this mechanism are, as I suspect, very far wrong. But this I can in no shape prove, till I shall have first represented the real condition of the fœtal heart. First, then, let it be observed, that every drop of blood which comes into the system is, either by the powers of the placenta, or by communion with the mother's system, oxydated blood. —One part of this blood, indeed, passes through the circulation of the liver before it reaches the heart, while another passes, more directly through the ductus venosus; but both are mixed, and the blood is all of

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which the two auricles were cut away to make every thing clear.—(*d*) The root of the aorta, known by (*ee*) its carotids.—(*g*) Is the root of the pulmonic artery—(*i*) the right and (*k*) the left pulmonic arteries—(*m*) the ductus arteriosus or middle branch, running into the aorta—(*n*) the place where they join—(*oo*) the aorta increased in size by this addition.

N. B. This heart is but a very little under the natural size in a new-born child.

* The umbilical arteries must be explained in another place.

one

one quality when it arrives at the auricle, in order to fill the heart, and to begin its course round the body. Now, since the blood is all of one quality, Nature could have no cause for dividing such blood into two portions; one to pass through the lungs, the other to pass over the body. She could have no motive for employing, as in the adult, two hearts. The design of Nature plainly is, to prepare a double heart, and keep it in reserve for the circulation of the adult, but to use it as a single heart in the fœtus. And see how simply this is accomplished. The two auricles communicate so freely by the foramen ovale, that they are as one: the two ventricles both deliver their blood into one vessel, the aorta; and they are also as one. The blood arrives by the cavas, fills the right auricle, and in the same moment fills, through the foramen ovale, the left auricle; so that the auricles are as one, and filled by one stroke; the two auricles act at once, and so the ventricles also are filled by one stroke; the aorta receives the blood of both ventricles at one stroke. So that, in the strictest sense of the word, the fœtus has but one single heart, the heart of the body (the function of the lungs being performed by the placenta, far from its proper system;) and when the function of its own lungs begins, then Nature, by the simplest of all mechanisms, divides the two hearts, that they may perform each its peculiar function. First, the flow of blood into the lungs deprives the ductus arteriosus of blood; and, secondly, this flow of blood coming round to the left auricle of the heart restores the balance, presses down the valve of the foramen ovale and makes the partition betwixt the auricles

auricles entire. In short, while the oval hole and ductus arteriosus are open, it is a single heart; and when they close, as they do the moment the child is born, it becomes the double or perfect heart.

Now the mistake which all physiologists have fallen into is this. They have not observed that no creature can live with a single heart, which has the oxydation of its blood performed by lungs. A fish lives by a single heart, because its blood is oxydated by gills, not by lungs: Insects live with a single heart, as their lungs, or the branches of their lungs, are distributed like arteries over all their body: The fœtus can live with a single heart, because its blood is oxydated by the placenta. And that this idea may make a more determined impression, it will be good to prove, that the function of the placenta actually is equivalent to the function of the lungs; and that it is the placenta itself that produces this change upon the blood, I am the rather inclined to believe, because we see the veins and arteries of the Chick spreading over the membranes of the egg, and we can observe the artery sending dark coloured blood into these membranes, while the vein brings back florid or oxydated blood.

If, during child-labour, the umbilical cord falls down before the head of the child, at first it is not pressed but beats strongly, and the fœtus is felt struggling in the womb; but when, after a few pains, the head descends into the pelvis, the cord is pressed betwixt the head and pelvis, the pulse falters, ceases; the child ceases to stir in the womb; and if not born in a few minutes is irrecoverably dead, and is

black

black in the face like one strangled or drowned. When a child comes with its feet or other parts of the body first, the head being last delivered, is difficulty delivered; the accoucher struggles long in bringing out the head; the umbilical cord is compressed all the while, and the child dies. The ductus arteriosus, nor the oval hole, cannot save the child, for it dies because it is deprived of the function of the placenta, which is the fœtal lungs; and this is the cause why it appears like one suffocated or drowned.

When the child is born, lay it upon your knee, the cord being uncut, and you will observe that the one function declines exactly as the other strengthens: That if the child do not breathe freely, the cord will continue to beat steadily, the placenta still continuing to perform the function of the lungs: That when the child begins to cry freely, the pulse of the cord and the function of the placenta cease at once. If the child breathe freely, but yet do not cry, and you tie the cord, it is instantly forced to cry for a fuller breath; and if a rash person tie the cord prematurely, when the child neither cries nor breathes, he cuts off the function of the placenta before the function of the lungs is established, and often the child is lost: this, in the hurry and officiousness of ignorant women, happens every day. If even after two days the child's breathing be much interrupted by coughing, crying, or any spasmodic affection of the lungs, Nature seeks again the function of the placenta, and the pulse returns into the chord so as to raise it from the belly of

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the child. These things prove what the best physiologists have forgotten, or have not known, that the fœtus has, in the function of the placenta, something equivalent to the function of the lungs.

One great mistake then runs through the whole of physiology. It has been universally believed that the free and easy transmission of the blood was the chief use of the lungs, as if they had acted like fanners to flap on the blood from the right to the left side of the heart. They affirmed, that either continued distention, or continued collapse, hindered the progress of the blood; and they also believed universally, that if but the ductus arteriosus or foramen ovale, or any thing, in short, were left open to let the blood pass, that person might live in spite of hanging, drowning, or suffocation of any kind.

This will be found to be the most perfect of all absurdities; and to alledge such a thing against all authors requires some kind of proof: it will suffice, if I prove it against a few of the most eminent, so much were the older authors wedded to this misapprehension of the dilatation of the lungs being useful only by driving forwards the blood, that, in the Parisian dissections, we find the following experiment made on purpose to prove the fact. "We have also made another experiment (say the Parisian dissectors*) to know more distinctly the necessity of the motion of the

* *N. B.* This was a wheel within a wheel; it was a committee of the great academy, who were separated into a smaller society for investigating the organization of all strange animals; and a very pretty account they gave of them, as shall be seen presently.

the

the lungs for the entire circulation of the blood. An injection being made by the right ventricle of the heart into the artery of the lungs of a dead Dog, it happens, that if one continue to make the lungs rise and sink alternately by means of bellows put into his trachea, the liquor pushed into the artery does easily pass and go through the vein into the left auricle; but when one ceases to blow, it passes not but with a great deal of difficulty," (page 262.)—Which doctrine is dilated into its full absurdity in the next paragraph. "Having viewed the difference of structure in a Tortoise and in a Dog, it is easy to give some probable reason of the phenomena of these experiments; and the reason is, that it is necessary that these vessels shall be dilated for the receiving of the blood of the right ventricle of the heart, and that they may be afterwards compressed in expiration to press out the blood, and make it pass into the left ventricle." Swammerdam indeed says, concerning the Frog's lungs, that an artery goes over them, which has no other purpose but to nourish the lungs; and that it is of the nature of those called bronchial arteries in Man. But the College of dissectors have plunged still deeper into this remarkable blunder; for they say (page 261.), in speaking of the lungs of Newts, Frogs, and other creatures which I have represented as having a pulmonic artery extremely small in proportion to their system, "that in such creatures the lungs have merely that quantity of blood passing through their substance which is necessary for their own particular nourishment;" which is saying in the plainest terms, that

that they have lungs (only, I suppose, that they may be like other creatures); but their lungs are of no manner of use, except to nourish themselves.

One should have thought that the folly of this opinion would have appeared more striking in proportion to the earnestness of these arguments, and that no subsequent author would have deigned to honour such an opinion so far even as to notice it: but behold the celebrated Haller not only adopts this notion very fully, but enriches it with further explanations, saying, "that the vessels are all, during the contraction of the lungs, forced into numerous angles and joint-like folds; that the angles are made even, and the passages of the blood more direct upon the expansion of the lungs." As if, forsooth, the lungs (which, as I shall presently demonstrate, scarcely move in respiration) folded and closed upon each other like the wings of a Butterfly or Beetle*. Santorini also represents the vessels of the lungs as thus collapsed, plaited, and folded a thousand various ways "assaissê et replié de mille manieres differents, &c." —"One éffect of expiration (says Haller) is so to compress all the arteries of the lungs, that they cannot receive the blood from the ventricle of the heart so freely as they are wont to do †.

* "Præterea, in vivo animale, cujus cor contrahitur, et in arterias pulmonales sanguinem data vi emittit, omnino nunc sanguis in eas arterias facilius, atque adeo celerius irrumpit, postquam deletus retardatricibus plicis, recta nunc sunt."

† Verum alter effectûs expirationis est utique pulmonis arterias ita comprimere, ut ne pari facilitate sanguinem a suo cordis ventriculo recipiant.

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" It must seem very strange for me, after saying that inflating the lungs restores an animal after apparent death, and recovers the drowned, to affirm that long continued respiration is fatal*; and yet we need not look long for the cause of this; for during this long continued inspiration, much blood must be gathered in the lungs, but none can get out†." Nothing is attributed, in his explanation, to the want of air, but all is attributed to the obstruction of the blood: yet if this were all, Amphibiæ woud need no lungs, fishes would need no gills, insects could need no air-tubes; for none of these assist the motions of the heart. Monro, who puts Haller to rights in every thing else, follows him in this. " In all amphibious animals, therefore," says Monro, " every part of the body may receive a considerable portion of blood, although the respiration and free passage of the blood through their lungs be interrupted," &c. (p. 21.) And the celebrated Blumenbach, the man

* " Paradoxum videri possit, ab inspiratione sanguinis in pulmonem commeatum expediri: inflato etiam aëre, quod genus est magnæ inspirationis, animalia moribunda reviviscere, et sanguinis per pulmones iter revocari: et tamen hanc eandem, adeo faventem sanguinis per pulmonem motui inspirationem, sola paulo diuturniori continuatione, anxietatem primo incredibilem facere, deinde, si vel voluntatis violento imperio tamen aer in pulmone retineatur, vel ab alia causa intra pulmonem copiosior servetur, denique sanissimum et fortissimum hominem subito interire."

† " Hujus nunc anxietatis et suffocationis, et denique mortis causam non est arduum invenire. Adparet enim, ab inspiratione diutius continuata, sanguinem in pulmonem quidem advenire, et congeri, exitum vero ex pulmone non invenire."

most

most admired on the continent for his Physiology, says, at p. 80. " Post extremam respirationem redeunti per venas cavas sanguini via sueta in pulmones nunc collapsos præcludatur*."

Thus I have proved, that it has been the opinion down to the present day, that the collapse or over-distention of the lungs are both equally opposite to the easy passage of the blood: but instead of going round about the matter slyly, as some lesser authors have done, I like rather the manner of the Reverend Dr. Hales, who says plumply, " that suffocation consists in the falling flat of the lungs," (p. 271.) He talks in this way, because, like Buffon, Derham, Des Cartes and some others, he was a philosopher by inclination, and by force a sort of an anatomist.

Now, the condition of the human lungs is quite opposite to all this; and also (in respect of distention) is less different from the lungs of reptiles than it is easy for any one bred up in the old doctrines to conceive.

In expiration the lungs do not even collapse in any sensible degree. Let us take for our data the common calculations concerning the quantity of air in the lungs, and let us see what they will do towards proving this opinion. The lungs are supposed to contain

* Mr. Kite, one of the latest writers on the recovery of drowned persons, has the same notion. " We inflate and empty the lungs (says he), in order by their expansion and contraction to FORCE the blood across from the right to the left side of the heart,"—and he expresses himself as perfectly indifferent what kind of air be used, foul or pure is all one.

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at the time of their utmost fulness about 220 cubic inches of air. When we continue breathing in a natural and easy way, we draw in and expel alternately about 40 cubic inches of air; but when we choose to force respiration, we find that we can expel without danger or harm 70 inches more; we can expel 110 inches of air, leaving only 110 inches remaining in the lungs. Now let us, for a moment, observe how little danger or distress it occasions when a forced respiration is made—such as is used in coughing, laughing, speaking, crying, expelling the child, urine, or feces, bracing up the body for the lifting of heavy weights, or other violent occasions, for which such forced respirations are by nature reserved. Let us notice how much forced respiration exceeds the ordinary respiration, and how small a proportion the quantity of an ordinary breathing, viz. 40, bears to 220, the whole quantity of air within the lungs. Reflecting thus what large inspirations of air we may take, and how very little we do take, we begin to perceive how gentle the motion of the lungs must be.

There remains always within the lungs a great mass of air, which I will call the permanent dilatation of the lungs, which, from the first movements of the child, from the hour of birth till death, and even after death, must remain in the lungs. This mass, equal to 220, cannot be entirely breathed out; even the utmost force of respiration expels but the half: this is never done but on extraordinary and most urgent occasions, which do indeed disturb the circula-

 tion;

tion; as coughing, laughing, crying, or running do. But this great mass is seldom so moved; it is regularly and gently agitated by the change of 40 parts of the 220 which we expire and draw in again at each breath: we do not empty and fill the lungs at each breath; there is on the contrary, a permanent expansion of the lungs, and a mass of air always in them; there is along with this a gentle and regular agitation; and there is changed at each respiration a small proportion of this mass of air. Our lungs are little different (in respect of distention) from those of Amphibiæ: for their lungs also, as I have described in the Frog, are permanently expanded, and at each respiration a little dilated and contracted; the air a little changed, a little moved, a little renewed; the change is in both cases placid and gentle, and hardly to be perceived.

With these opinions concerning the state of our lungs, nothing can appear to me more coarse than the notion of their being entirely filled and emptied at each breath; nothing more ignorant than the supposing them to fall flat, as Hales expresses it, so as to hinder the motion of the blood: and the grossness of this opinion appears in its true light when I put down this last proof, viz. that for each act of respiration there are four pulses of the artery, or four strokes of the heart. Is it not plain, then, to the meanest apprehension, that if the blood moves twice through the lungs in expiration, and twice during inspiration; or, in other words, if there be four strokes of the artery for each respiration, and if each of the four pulses be equally strong, that the blood passes

through

through the lungs in all states and conditions with equal ease*?

It is also universally believed, and it is indeed a most legitimate conclusion, from this doctrine of the collapse of the lungs hindering the passage of the blood, that if but the foramen ovale or any passage be left open to let through the blood, that person will live without breathing.

It has been affirmed, that the Seal, the Beaver, the Otter, have the foramen ovale open. In the Seal, the Parisian dissectors found the oval hole open as in a child; but when they came to the foramen ovale of the Beaver and Otter, they found them, and sore against their will, quite close. In their disappointment they could have said any thing; but all that they thought prudent to say was that the Beaver had not been in the water for a long while, not even to refresh himself†, and the Otter had been close penned up in his hut at Versailles; and so the foramen ovale had closed in these poor beasts quite close; and behold they were no longer Otters and Beavers, but

* Their old and favourite experiment, so often repeated by Hooke, Croone, and others, before our Royal Society, viz. of blowing up the lungs of a Dog, and then compressing them, is good for nothing: for there the thorax is cut clean away; the permanent distention of the lungs is entirely lost; and then, no doubt, there is such a collapse of the lungs, as may, or rather must, hinder respiration; for the lungs are alternately distended to the greatest degree, and then emptied as completely.

† The Beaver sits in his hut just up to the hips in the water, and builds his hut so that he may sit just up to the hips.

little better than dogs*. Although Haller† declares that he had found the foramen ovale open in a man who was hanged; though Rœderer, Chesselden, and many creditable witnesses, have testified the same; still there has gone along with these confused doctrines about the foramen ovale a kind of dream (like that concerning the transfusion of the blood), that if but the foramen ovale could be preserved open, Man even might be made an amphibious creature. At first this notion began to peep through the mists of this doctrine; and you might find an author, when he had dissected a person with the foramen ovale open, insinuating by oblique notions, what a vast pity it was that the man had not known, during his life, how kind nature had been to him, and what a perfect diver he was! while another says plainly, on a like occasion, "what a pity it was that this child did not live!" we should have seen almost an amphibious human animal, at least a most notable diver‡. On this

* "Cette ouverture, qu'on appelle le trou ovalaire dans le fœtus, fait l'anastomose par le moyen de laquelle le sang va de la veine cave dans l'aorte sans passer au travers du poumon; et c'est apparemment pour une même usage que ce passage se trouve dans le veau marin que dans le fœtus, à cause du besoin que l'un et l'autre ont de se passer de la respiration, sçavoir le veau marin pendant qu'il est plongé dans l'eau, et le fœtus pendant qu'il est dans le ventre de sa mere, où il est certain que les anastomoses servent a décharger le poumon de l'abondance du sang qui le suffoqueroit."—Vid. *Acad. de Sciences*, Anno 1699, page 140.

† Vol. II. Part 2. p. 11.

‡ Mr. Chemineau says, " On auroit vue avec étonnement un Homme presque amphibie comme la Tortuë." Page 38.

slender

slender ground they told the most wonderful tales, among which Pechlinus's story of the Tronningholm gardener is one of the prettiest. " The ice having broken, the gardener, in trying to help out someothers, as frequently happens, slipt in himself into a place full eighteen yards deep. There he no sooner touched the bottom, than he felt as if you had clapt a plasterover his mouth : his feet stuck fast, his body became rigid, and he stood there as stiff as a stake, with no one of his senses about him, except only that he thought he heard all the while the Stockholm bells ringing most plesantly; and there he stood for sixteen hours, the folks seeking him up and down, and wondering where he could be: at last having found him, they hooked him out with a pole; and after much warming, and rubbing, and working, and giving him hot drinks, they got his blood to circulate, and brought him to life again. He had sense enough, however, he said to feel their hook; and indeed they had angled so ill, that his head was all bruised, and he had terrible headachs: but, however, the Queen-Mother gave him a good pension, and he was sixty-five years of age when Pechlinus wrote.*"

This

* Hortulanus Tronningholmensis etiamnum vivens, annos natus 65, pro illa ætate satis adhuc valens et vegetus, cum ante 18 annos alii in aquas delapso opem ferre vellet, forte fortuna et ipse per glaciem incautius procedens, aquas incidit 18 ulnas profundas: *ubi ille, corpore erecto quasi ad perpendiculum, pedibus fundo adhæsit.* Constitit sic per 16 horas, antequam produceretur in auras. Dixit autem, simul ac infra aquarum superficiem fuit demersus, *statim obriguisse totum*, et, si quem tum habuit motum et sensum,



amisisse

This is one of the many stories of men preserved by the foramen ovale not having been shut. At first, I say, this opinion began to peep out in hints and reflections; then it strengthened into wonderful tales of people being recovered who had been under the water six days; till at last a great genius undertook to make water-whelps upon a new principle, viz. with the foramen ovale open. This great genius was the Count de Buffon. Indeed even this very year a very celebrated author, Dr. Beddoes, forgetting, perhaps, how successful Buffon is, tells us (page 41), that " by frequent immersion in water the association betwixt the heart and lungs might perhaps be dissolved, and

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amisisse nisi quod sonantes Stockholmii campanas etiam sub aquis obscurius percipere sibi sit visus. *Sensit etiam, statim sese velut vesiculam ori applicasse,* adeo ut aqua nulla os penetraverit, in aures vero transitum, etiam sentiente illo, habuerit; atque inde auditum suum debilitatum aliquandiu esse. Hoc statum dum 16 horas permansit frustra quæsitus, tandem repertum, conto in capit infixo, cujus etiam sensum se habuisse dixit, fundo extraxerunt, sperantes ex more aut persuasione gentis revicturum esse. Itaque pannis linteisque productum obvolvunt, ne aer admitti possit perniciosus futurus subito illapsu! Custoditum sic satis ab aëre sensim sensimque tepidiore loco admovent mox calidis adoriuntur fasciis, fricant, radunt, et sufflaminatum tot horis sanguinis corporisque motum negotiosa illa opera reducunt: denique antapoplecticis et genialibus liquoribus vitæ reddunt et pristinæ mobilitati. Retulit is atque ostendit se etiamnum in capite circumferre vestigia violentiæ a conto illatæ et cephalalgiis vexari gravissimis. Et propter hunc ipsum casum, religiose a popularibus, et hujusce rei testibus probatum, Serenissimæ Reginæ Matris munificentia et annuo stipendio est donatus."

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an animal he inured to live commodiously under water for any time."

Let us move just a step backwards in this new trade of making amphibious animals, and observe how the celebrated Buffon succeeded. "I procured a pregnant bitch (says Buffon) of the large greyhound kind; and when just about to litter, I fixed her so in a bucket full of warm water, that her hinder parts were entirely covered. In this situation she brought forth three puppies which, after being disengaged from their membranes, were immersed in a fluid nearly of an equal temperature with that of the amnios. After assisting the mother, and washing the puppies in this water, I suddenly removed them into a pail of warm milk, without allowing them time to respire. I put them into the milk in preference to the water, that they might have an opportunity of taking some food, if they found a desire for it. I kept them immersed in the milk for more than half an hour; and when taken out of it, all the three were alive. They began to breathe, and they discharged a quantity of fluid matter by the mouth. I allowed them to respire about half an hour, and again immersed them in the warm milk, where they remained another half hour. I then took them out; two of them were still vigorous, but the third seemed to languish; I therefore ordered it to be carried to the mother; which besides the three brought forth in the water, had littered other six in the natural manner. The puppy which was born in the water and had continued one half hour in warm milk before it was allowed to breathe, and another half hour after it had

 respired,

respired, seemed to be very little incommoded; for it soon recovered, and was as active and lively as those which had received no injury. Of the six that were brought forth in the air, I threw away four; so that there remained only two with the mother, beside the one that had been littered in the water. I continued my experiments upon the other two which had been twice immersed in the milk: After allowing them to breathe about half an hour, I plunged them a third time into the milk, where they remained another half hour. Whether they swallowed any of the milk, I could not determine; but when removed, they appeared to be nearly as vigorous as before their immersion." "I pushed these trials no farther: but I learned enough to convince me, that respiration is not so indispensibly necessary to the existence of a new born animal as to an adult; and that by employing certain precautions, it is, perhaps, possible to keep the foramen ovale open; and, by this means, produce excellent divers, or a species of amphibious animals, which would be able to live equally in air or in water."

I am sorry to say that I cannot pay Mr. Buffon the compliment of thinking that he was deceived in so simple an affair as this; yet he certainly could not succeed. I leave it with my reader to judge what shall be said of Mr. Buffon; for it was not the foramen ovale that he was to keep open, if he wanted to make Amphibiæ; but, since the function of the placenta was just cut off in these whelps, and since he did not allow them the office of the lungs, he was to seek for some other third function, which could stand in place of the functions

tions of the placenta and lungs; and since no such function has yet been observed, I judge from all the principles which I have laid down, that Mr. Buffon was telling a vain-glorious idle tale; that he was conscious that he had succeeded in no degree; and that he could no more have converted them into amphibious animals, than he could have made them what they were, viz. plain whelps. "Sed quis fallat omnisciam, ut sic loquar, naturem? Illa non colludit nostris erroribus, et quod ignorantia celaverat suo detegit tempore."

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## CHAP. V.

### OF MALCONFORMATIONS OF THE HEART, AND OTHER CAUSES, PREVENTING THE DUE OXYDATION OF THE BLOOD.

We are at no period of life, from the cradle to the grave, exempted from those diseases which prevent the due oxydation of the blood. They often are born with us; they often overtake us when advanced in life; they cause an anxiety and misery, which exceeds all other distress: pain and suffering of every other kind humanity can bear, but the feeling of instant dissolution is what the noblest mind sinks under. We

know

know by the pale and subsiding countenance how awful the inward feelings are, and woe be to him who has not feeling enough to sympathise with this distress, and an anxious desire to understand the cause, and to alleviate the misery, of inward diseases which he cannot cure!

These are seducing motives, and might of themselves have drawn me on to give this slight sketch of the malconformations and diseases of the heart: but I feel also the stronger motives of duty and necessity; for truly, without some knowledge of the ill organized, irregular, and diseased heart, the structure and functions of the heart in its sounder state would be but poorly understood. This sketch, then, is the last part of this anatomy of the heart.

While the following history serves to correct our notions of the mechanism of the heart, we must also observe how it explains and illustrates up to a much higher point the combined functions of the heart and lungs, viz. the oxydation of the blood. Perhaps nothing can better explain the effects of a full and healthy oxydation, than a sparing oxydation of the blood, such as produces disease.

The fœtus alone can live with its single heart; it lives in the womb by its having a heart different from that of an adult. A fœtus, then, being born, cannot live with that heart which served it in the womb; and Nature, as I have exained already, divides the single heart, and there is then a heart for the lungs and a heart for the body. But if any fault in the organization prevent this separation of the heart; if the foramen ovale be preserved open; or if there should be

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any hole in the septum betwixt the ventricles of the heart; if the pulmonic artery do not admit the blood, now that the child is born, and should breathe the air; if the aorta arise from the right ventricle, so as to carry off all the blood from the lungs; or if the aorta be so displaced, that its mouth stands in part over both ventricles, so as to receive the blood of both—then the organization, movements, functions of the heart; are all wrong; no blood passes into the lungs, the child cannot live; it either dies immediately in convulsive struggles, or lives in misery but a few years.

It is not in this rapid enumeration that these varieties of malconformation can be understood, nor yet do they deserve to be minutely detailed. I shall keep the middle path; and those of my readers will easily follow me who have studied the mechanism of the heart; concerning which this subject will recal to their memory all the important facts.

The most usual of all these disorders of the heart is some fault in the pulmonic artery; and that disorder again is fruitful of others: for if the pulmonic artery cannot receive its blood, the foramen ovale cannot close: then the blood cannot circulate nor pass into the lungs when they first expand; then the office of the right heart is taken away, it has no power but to drive the blood with struggles through the foramen ovale into the left heart; the left heart then drives this blood, unoxydated as it is, into the aorta: the heart is now a single heart; it is the left heart alone that receives or circulates the blood: either it labours but for a few pulses, and then the child, after a convulsive

vulsive struggle, expires; or there is some degree of opening in the pulmonic artery, a little blood passes through it into the lungs; the child is by that enabled to struggle with its convulsive pangs for eight or ten days, and then expires.

Such a scene the celebrated Dr. Hunter once witnessed; and there was, I perceive, in that heart a peculiarity very much to be admired. The chief fault was in the pulmonic artery, which was contracted into a solid substance or cord absolutely and completely impervious, so that the lungs had never received one drop of blood by the pulmonic artery. And here I must stop to notice one thing which I have always suspected, and which this dissection proves, viz. that though it is natural to believe, and the best physiologists suppose it, that some blood, as much at least as to support the form of the pulmonic vessels, passes through the fœtal lungs; yet here is direct proof that a well nourished child may be born capable of breathing, and in which the pulmonic vessels are all free except at the heart, in which not one drop of blood ever has passed into the lungs. But chiefly it is to be observed, that this child, with its pulmonic artery quite impervious, could not have struggled a single day, far less ten days, without some proportion of oxydated blood! and accordingly we find that it had a small portion, just such as supported life for a few days; which small proportion it obtained thus: The blood went to be oxydated, not from the right ventricle into the pulmonic artery, but from the left ventricle into the aorta; from thence into the ductus arteriosus; and

and then, by a retrograde course, backwards through the lungs; and then by the pulmonic veins it was returned oxydated into the left side of the heart, from whence it came. This child accordingly lived a few days, and could not live longer; because this difficult circulation was continually accumulating a quantity of black blood in the right side of the heart.

This child, then, had a heart resembling that of the Newt or Frog; for the pulmonic artery was closed, and the right heart of no value; the left heart pushed its blood into the aorta, and the aorta, as we may express it, sent a side branch into the lungs. In this first instance, then, of malconformation, the child could not live, because it wanted t e pulmonary artery, and of course the office of the right ventricle: it had but a single heart.

Next to this disorder of the pulmonic artery, viz. being obliterated or being closed, is this: That the aorta, in place of arising distinctly either from the right or from the left ventricle, is so placed, that its root stands directly over the septum ventriculorum, or partition of the ventricles; that the partition is perforated with a large hole, opening a very free passage from side to side; and that the heart being cut up, we find, upon thrusting down the finger into the aorta, that it passes with equal ease into the right or into the left side of the heart—All which we are the less surprised at, when we remember that in the Chick in ovo, the parts of the heart are all separate pieces, which are joined one to another; and that in the fœtus of other creatures, in the Frog for example, the auricle, ventricle,

ventricle, and artery, are first seen at a distance from each other, and then joined*.

In this conformation of the heart, the single heart appears again in a new form, and the office of the right or pulmonic side of the heart is well nigh annihilated. First, The pulmonic artery is small, sometimes almost close: Secondly, The aorta, arising as well from the right as from the left ventricle, carries off one half of that blood which should be circulated through the lungs: And, lastly, That blood, small as it is in quantity, which has passed through the lungs, is brought round to the left side of the heart; but the left side is not as it should be, close, to keep this purer blood for the circulation of the body, but it is mixed with the blood of the right side, through the perforated septum, so that its virtues, as oxydated blood, are diluted or almost lost.

If the pulmonic artery were unaffected, and the aorta placed equally over both ventricles, then the one half exactly of that blood which should be oxydated would undergo the change. But in all these malconformations, the root of the pulmonic artery also is in fault; it is narrow; it is so small, that at first opening such a body it alone attracts the eye; its

* I do not mean to argue, that when we first see them, they are so little connected, that one could be awkwardly joined to the other, nor that they have no real connection, because it appears as if they had not; but merely this, that as they seem, like the parts of the eye, to be organized in separate pieces, I should sooner expect an unnatural displacement of the vessels of the heart than in the middle of the femoral artery.

mouth

mouth is sometimes so beset with a sort of fleshy granulous papillæ, that there is hardly left opening enough to pass a silver probe. The degree of contraction in the pulmonic artery is the true measure of all the oxydated blood which that system can receive; but in such a system the quantity is still farther reduced by various accidents of the organization. Thus, for example,—The pulmonic artery is, we shall suppose, but one third of its natural size, and the original quantity of oxydated blood is proportionably small;—next, the foramen ovale, being open, carries off much blood towards the left auricle; the aorta, planted over the right ventricle, carries off also much blood.—But let us suppose, that still as much remains as to fill the pulmonic artery to its full; when the pure blood comes round to the left side it is mixed through the foramen ovale, and through the breach of the septum, with a quantity of black blood, which is continually accumulating upon it; and the small quantity of oxydated blood is, if I may use the expression, drowned in the general mass.

That I may explain the point of its accumulating a little farther, let me repeat, that even in a child which has died on the tenth day of such a disorder, the heart is crammed with dark-coloured blood: That in those children which have lived two or three years under such a distress, the heart has been greatly enlarged: That in a boy dissected by Sandifort, who died at fifteen, the thing that was first seen upon opening the body was, not the lungs covering the heart and lapping over it, but a large mass, lying betwixt the lungs, oppressing them; and pushing them aside

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in every direction. This was the pericardium covering a heart of enormous size, filling the thorax, and reaching almost to the first rib; very little of the right lobe of the lungs, and none almost of the left, was to be seen; the veins in the upper part of the thorax, viz. the subclavian and jugulars, were choaked by the pressure, and much distended; the heart itself was full of blood, and the coronary veins so turgid, that it resembled a most minute and beautiful injection of the heart.

But it is most of all singular, that this heart was so enlarged, that the great veins (which are indeed as reservoirs for the right side of the heart), and especially the upper cava, dilated along with it in such a degree, that there was felt distinctly a pulsation in the neck by a sort of back stroke every time the heart beat.

Still a child, even with a heart so ill organized, may struggle through all the weakness and all the diseases of childhood* for a few years; but they are years of complete misery; and still, as is proved by much sad experience, the boy cannot live, but must die.

Another conformation, the strangest of all, is that in which new parts are added to the circulating system, as if with design to make it resemble the heart of an amphibious creature; for it happens sometimes, that there is as it were a third heart interposed. For example, the two vena cavas end in the right auricle,

* Sandifort attended a puer cœruleus, who, in addition to his chief disease, passed through the small-pox and measles safely, and attained the age of fifteen.

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the pulmonic veins enter into the left auricle and the right and left ventricles receive their blood from their auricles in the usual way; yet the right ventricle sends out no pulmonary artery, the left ventricle sends out no aorta; but both of them pour their blood into a middle ventricle, and the arteries go out from it: and here, as the blood is fairly delivered by both ventricles into this third ventricle, and as the pulmonic artery and aorta both arise from it, there is, of course, a fair division of the blood; and of the quantity which should be oxydated, exactly one-half undergoes that change. This is somewhat like the heart of the Turtle; it is plainly the structure of an amphibious heart, a single heart; for though there be three cavities, yet are they single in their function; it is single heart with half oxydated blood. Such a heart is sufficient for amphibiæ, or for the fœtus, but not for a child, which must breathe and have a double heart.

These are a few of the varieties of the imperfect heart; but the sufferings of children who are born with these imperfections, the marks of imperfect oxydation, and the manner of their life and death, was a chief motive for entering on this subject.

When the heart is so imperfect that the child lives but a few days, its sufferings are slight, and not lingering, so that we cannot mark them: They are not explained to us by any account of its inward feelings: They are all accumulated into one terrible struggle, in which we see the worst marks of ill oxydated blood.

The child is born well and healthy, it cries and draws its breath, it is removed from the mother; the

function of the placenta ceases, but there is no other to succeed it: the child turns black in the face, struggles for breath, and is convulsed; and without any apparent cause it seems in the agonies of death: But yet it lives, it becomes black all over the body; the blackness never goes off except when it changes sometimes into a deadly ash-colour. The child continues for a few days labouring under almost unceasing convulsions which, growing gradually weaker, it at last expires; and while it lives, the heart palpitates, sometimes it throbs so, that it can be distinguished at a distance by the eye. Dr. Hunter, in the child which I have already mentioned, laid his hand upon the breast, and the throbbing which he felt there was terrible to him.

When the child has the heart so formed as to admit into the lungs even a very small proportion of blood, it struggles through the first years of life, and its protracted sufferings can be more easily observed. Then no mark of ill oxydated blood is wanting; every thing is the reverse of health, or the natural appearance flushed and florid of a growing child; its colour is always dark, its motions languid and powerless; it is cold, so that the parents must keep it carefully wrapped in flannels and furs to preserve any thing of vital heat; its breathing is difficult and distressed; fits come upon it at times; and if the child has begun to walk, the least hurry, or fear, or quick step, even walking across the room, brings a return of the fit: in which the extremities are deadly cold, the face black, the breathing one continued struggle, and

the end of the fit is the obtaining of a degree of relief, which happens in a most singular way.

The coldness, the liver, the languor, the fainting, the struggles for free breathing, are all marks of ill oxydated blood. The convulsive paroxysm is a sure consequence of the want of stimulus and force, and of blood accumulating at the right side of the heart. If, then, the child fall down in this paroxysm, it is the very surest proof that ordinary respiration will not save him from the struggle; if during the fit he breathe so that he recovers, and that presently his strength, colour, spirits, every thing, is in a degree restored; then is it plain that the respiration during the fit, imperfect as it appears to us, is really more effectual than ordinary respiration.

When we observe which is the most natural way of obtaining relief, and notice the very peculiar manner in which these children breathe, we shall understand why they are breathing best when we believe they are hardly getting breath, and how they are recovering slowly when we think them labouring in the greatest danger. The child feeling the growing oppression at its breast, if it be young, signifies a desire to be turned upon its face; if not indulged, it contrives to turn itself that way before its hard struggle begins. When the child begins to breathe hard, it drives out the air with a sudden exertion, and apparent pain; he remains longer without respiration than an adult could do; his expirations are attended with a sort of scream. What can this way of breathing mean? To my apprehension it implies that kind

of breathing which I have called forced respiration, and no other plainly can serve.

The ordinary respiration, by which we draw in 40 cubic ounces of air, has failed; the fit is approaching, because that quantity of air will not suffice. However rapidly the child breathes, however rapidly the heart palpitates, it will not do, because there are but 40 ounces of pure air mixed with the whole of that great mass which remains always in the lungs. Then the child, driven by instinct, provides for the fullest respiration: it turns upon its face, that the weight may help to compress the thorax; it forces with all its power, and seems to cease from breathing, and refrains a long while in that state, because it is emptying and compressing the lungs. Then its purpose is accomplished; the lungs are more emptied than in ordinary respiration; it draws in the largest draught of air, utters a sort of scream, seems quiet again; and again, by pressing its breast, and by contortions (convulsive like of its body), it empties its lungs at a distant interval, and receives again the fullest draught of air. It is this forced respiration that brings into the lungs 70 cubic inches of air more than the usual respiration does. This, then, is three times more effectual than ordinary breathing; and when a boy grown up to those years in which he knows the warnings of his disorder, and has found out this relief; when such a boy by pressing upon the corner of a table, or by throwing himself upon the ground, prevents or alleviates his paroxysms, in what way can it be but by practising for a time this deeper respiration? pressing the chest, forcing and compressing the lungs beyond their usual degree of collapse,

collapse, and so obtaining a fuller draught, a draught of 110 ounces of air, to be mixed with the 110 ounces which must always remain in the lungs ?

After half an hour of a kind of breathing, most awful to behold, but much more effectual than common breathing, the child recovers slowly. The boy, when advanced a few years, knows how to prevent the fit; but the child of two or three years old knows only how to struggle with it: yet this struggle being a more effectual breathing, the child is relieved at once from an anxiety, and oppression, and throbbing, which precedes the fit for many days; the languor goes off, the heat in some degree returns, and the lips acquire a vermillion colour and the skin a higher tint, which last for many hours after the fit is gone.

In those children, again, which have the heart so formed that they may live not two or three years only, but to the age of 15 years, it naturally happens that the symptoms follow each other in their course very slowly; and the ill oxydation of the blood in this its slower progress it is very curious to observe.

There is one thing in the economy of the fœtus very singular, viz. that while it is receiving much oxydated blood from the mother, but a small portion goes through the ductus venosus directly to the heart, much of it circulates through the liver, and is spoiled (we must suppose.) What then can this mean? Surely the child, the chick, the fœtus of every kind, needs less of this principle of oxygene: the fœtus lives (if this be so) like an amphibious creature; perhaps it has little oxydated blood; yet being totally deprived of that little, it soon dies. Perhaps the fœtus, living

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the life of an amphibious creature, does not want also that peculiar tenacity of life which characterises that class; for the struggles and sufferings which a weakly infant indures, before it parts with life, are matter of observation even among the vulgar. For this reason I believe it is that children, having a heart so ill arranged that absolutely they cannot live beyond the years of puberty, yet during the first year feel no complaint, and seem thriving and healthy; the vegetating life of a sucking child saves it from all dangers of hurried respiration and rapid pulse.—But when it leaves the breast: when it begins to stir and move; when its blood, moving languidly, begins slowly to accumulate at its heart; when the properties of its living fibres change, so as to require a fuller supply of oxygene from the blood—then the ill colour, languor, palpitations, slighter fits, and all the marks of its disease, begin; and often its colour gradually changes, and it becomes the puer cœruleus, or livid child, before we can perceive by any other marks how dangerous a condition it is in.

In one child* the first year had elapsed before the very slightest of those complaints came on, which ended in death at a very distant period of 15 years. At first its finger nails were observed to be livid, yet not continually; the colour varied, but still the nails were unnaturally livid, so as to alarm and surprise the parents; but there was as yet no reason to desire advice. The child seemed healthy, began to use its legs, and in the second year it walked alone.—Next it happened, that one day after being forced to take a medicine, not without some resistance, his face

* Vide Sandifort.

was

was on the following day freckled with red spots, which soon changed to a livid hue. Now the lassitude and chillness came on; motion or exercise were more and more oppressive to the boy; till at last when he fatigued or hurried himself, the hands and feet became livid, the mouth and tongue became almost black, and last of all those fits came on in which the whole body becomes livid or black.

This is the progress of this darker colour of the body; but his other complaints also advanced with a very slow and regular pace. He increased in stature, his appetite was good, he complained of great lassitude, of headach, with a sort of gravitating pain, of anxieties, especially during the winter months, and of such extreme coldness, that neither fire in winter nor summer's sun could warm him; he never felt heat except when just wrapped up and newly laid in bed.

Now the blood began to accumulate; the struggles of the heart began; and so terrible were the throbbings of his heart at times, that they might be seen or even heard. Actual faintings succeeded; the poor boy, now eleven years of age, knew that he was to die; he said, that "no one could know or cure his illness, and that no one could imagine what feelings he had here at his heart."

Motion was now quite impossible; upon the slightest effort saliva flowed from his mouth, a fainting fit ensued, and he continued for a little while blind. All that he was wont to delight in was now indifferent to him; he could not move; his face was turgid, his eyes prominent, his feet were swelled with an œdema, his eyes dead and heavy, expressive of some

 inward

inward distress; when he was put to bed his anxieties were very great, and thus he died a slow and miserable death.

Sometimes a child wants spirit or strength to strive against the lassitude of this disease. A girl under Vasalva's care lived to her fifteenth year; but from her infancy, from her very birth, she had lain in bed, partly on account of sickness, but chiefly on account of extreme weakness. She had a short and difficult breathing, and her skin was tinged all over with a livid colour; her quiet state saved her from the suffocating paroxysms; but her heart was just like all the others, the foramen ovale open, and the pulmonic artery closed.

These, then, are the marks of ill-oxydated blood: a livid colour, coldness which nothing can remove, oppression and anxiety of the breast, palpitations and difficult breathing; and when the blood is by passion or motion hurried too fast towards the right side of the heart, then come fits, which last a longer or shorter time in proportion as they have been long delayed, and which end in death. And last of all, I would rank among these consequences an imperfect nourishment, for all the boys have been small, most of them particularly slender; and one boy especially, of fifteen years of age, is mentioned by Hunter, who, in respect of tallness, was just what you should expect at his years, but slender to a wonderful degree; not as if wasted by consumption, but as if by natural habit. His form was quite surprising, so that Hunter could give no idea of his shape, otherwise than by comparing his body with that of a Greyhound; and his

legs,

legs, he says, put him in mind of those of a Crane, or some tall water-fowl.

The consequences must be alike, whether it be that the heart sends no blood towards the lungs, or that the lungs cannot receive that blood; and the malconformations of the heart are hardly more frequent than those of the lungs; and both, we may be well assured, are infinitely more frequent than we suppose; especially when we observe how many children die suddenly, discoloured, and in convulsions; and how many of those advanced in years have lived very miserable with complaints in the breast.

A young man of twenty-four years of age, by birth a Pole, and at the time of his death a soldier in the German service, had been continually oppressed from his cradle upwards with difficult breathing and anxieties at his breast. He had been three or four times relieved from slighter complaints of the breast; but at last the bleedings and demulcent medicines failed: he lay ill in the military hospital two months, where of course his complaints were correctly known. He had none but the slighter degrees of difficult breathing; when one day sitting up in bed he suddenly expired. Being opened, the right side of the lungs was found to be totally wanting; not destroyed by disease, as we have often seen, not oppressed by water nor eroded by pus, but entirely wanting; a peculiarity which he had from his mother's womb, for it was attended with a peculiar arrangement of the vessels. On the right side there was no vestige of the lungs, not even the smallest button to mark where they might have been;

been; there was no branch of the trachea for the right lobe intended by Nature, but both the legs of the trachea plunged into the left lung, which was large: There was no forking of the pulmonary artery to give a branch to the right side, but the whole trunk of the pulmonic artery plunged into the left lung.

But if one should suspect that there might have been once a right branch, the lungs destroyed, and the mouths curiously united by that mucus which the membranes of the viscera, and the pleura especially, throw out when inflamed; there are still other cases which must remove all our doubts, especially that of a young man*, who died in a very lingering way, and in whom before his death there was plainly perceived, along with his slight anxieties, a pulsation in the right side of the breast. Upon opening his body, there was found in the left side neither lungs nor heart; nor, upon the most careful examination (seeking for the wasted lung), could there be found the smallest remains of lungs, bronchiæ, pulmonic arteries, or the slightest evidence that any such parts had ever been. But the surest proof of this remains behind, for the heart stood in the right side of the chest; it stood perpendicularly, quite upright like a Dog's; it gave out a right pulmonic artery, but there was not even the smallest vestige of any artery having been appointed for the left lobe. We must not say, yet his chest may have been full enough of lungs and heart, and he may have had a well-oxydated blood; in which case it was

* Under the care of Dr. Heberden. Vid. *Acta Vendobonensis*.

no

no very dangerous derangement that his lungs were all on the right side, more than if his liver had been on the left. But let us notice that the aorta was extremely small; the diameter of the aorta is the true measure of the blood which is received from the lungs. Where the aorta is small, surely the lungs are not good, nor the system fully supplied with oxydated blood.

We also know that though the vessels of the lungs themselves may be natural and well arranged, the lungs may still be amiss; they may want the proper structure of cells in which the blood should be exposed; they may be encumbered with tumours arising out of their substance, by which they will be prevented from dilating. One is pleased to find in old authors good descriptions of diseases which have remained for ages unknown; and among these I reckon that of the celebrated Spindler, whose description I admire as much as that of any succeeding author.

The child of a certain prince having died after a few days of great suffering, Spindler opened the body, and found all sound and right, except that there were seated upon the two lungs two tubercles of a variegated red colour, as were the lungs themselves; which tumours, no doubt, hindered the passage of the blood, which he expresses with a correctness in respect of physiology quite unknown in those times. "Quæ vomicæ procul dubio hujus asphyxiæ causæ extitere denegata circulatione ex dextro in sinistrum cordis ventriculum." His description of the disease so long before it was properly understood is curious: "During the eight days in which the child lived, it had never

never cried strongly nor clearly, had never sucked, had never been regular in its bowels, breathed as if its sides had been blown up; it was suddenly seized with a fit, which seemed epileptic, soon went off, but soon returned; the whole face and body became first red, then of a copper colour; the breathing was interrupted, the eyes immoveable, the feet and hands lay almost lifeless; it suffered at least a hundred of these fits before it expired."

To enumerate those cases where a defect of the lungs were the consequence, not of malconformation, but of disease, were a business quite inconsistent with my design; yet I wish to record these two.—First, It has been long observed, that by long continued suppuration, the lungs are often so wasted that not a bud or particle of them remains: sometimes these patients survive, dragging on a languid and miserable existence, enjoying no freedom, life, nor spirits; and the cause of their frequent ailments is discovered at their death. The lungs also may be thus compressed even by the mere pressure of water within the chest, which has caused such a subsiding, or rather absorption, of the lungs, without any ulcer of their surface, that one lung has been oppressed till it became no more than three lines in thickness; and indeed it was not easily found: so Haller says in his Commentary upon Boerhaave. But of all the strange things which Haller or any man has ever related, what he tells in the following words is the most incredible; at least it is so improbable as to be incredible. "A man having died of a lingering disease occasioned by a fall, the left lobe of the lungs was not to be found; that side of

of the chest was full of a coagulable serum; but the aspera arteria and large arteries and veins (a thing which I never could have believed, had I not seen it myself) opened with gaping orifices into the cavity of the thorax, as if they had been cut across; so that it was very hard to conceive what had prevented the blood from pouring out." Haller, p. 34.

Secondly, In the peripneumonia notha there is not merely an inflammation of the pleura, as the name expresses, but of the lungs themselves; and it is not from inflammation, pain, fever, or acute suffering, that they die; but because the lungs are entirely crammed with blood; the heart can no longer move; they are not sensible of their dangerous state, but are suffocated in a moment, and die without a groan. It seems more frequent in other countries, than in this, though no country is exempted. When this disease comes upon a place, it comes with all the frequency and destruction of an epidemic disease; and the sudden unexpected deaths are terrible. Vasalva found an old gentleman going abroad in the morning, and prevented him, questioning him about his complaints, which he himself thought very slight: but Vasalva gave notice privately to the servants to expect nothing better than their master's death; and notwithstanding all assistance, he was that very evening dead.

The pulse is weak, the cough slight, the difficulty of breathing more anxious than painful; the face sunk in the features and flushed, or rather of a lurid colour, except when it is cadaverous, pale, and sallow; the suffocation is sudden; the lungs have, as

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Morgagni expresses it, a liver-like, solid consistence; they have no longer the cellular appearance of lungs, for their bronchiæ are crammed with blood; their common cellular texture is also full of exuded blood; they are dense, solid, very heavy, and black, and they sink in water like the lungs of a fœtus. The heart is so curbed in its actions, that it gives but a small, feeble, and trembling pulse: and even in a few days (as in the fœtus having an imperfect organization) the heart is wonderfully dilated and enlarged, and filled with fluid and grumous blood. Haller laments the death of friends by this terrible disease, and especially of his own son, "whose body he gave to be opened by those skilled in dissections."

Perhaps the heart may be too small for the system to which it belongs; and this, I doubt not, had been the case with that boy in whom Kerkringius found it so small, that though the boy was nine years old, the heart (*i. e.* the ventricles) was no bigger than that of a fœtus; and the whole heart, auricles, ventricles and all, was no bigger than that of a child born at the full time. But in proportion as the heart was small the vessels were large, not at all aneurismal, but of such a size, and scarcely of such a size, as might suit the heart of a boy of nine years old. This boy had for five years been hectic, that is to say, he had been troubled with no formed disease, but with continual distress, anxiety, weakness, and quick pulse. This heart was plainly inadequate to the functions of any system; but the case is too slightly sketched for us to find any decided marks of ill oxydated blood.

But

But that the heart may be too big for its system, is a melancholy fact; for when it becomes relaxed, it enlarges, and as it grows in bulk loses in power. That the heart is enlarged merely by weakness, by submitting to dilatation, by wanting sufficient power to free itself of accumulating blood, is very plain; for in the plague, in low and pestilential fevers, even in nervous affections, it sometimes enlarges, and from a temporary becomes a mechanical and fixed disease. How often do we read in the preface to such dissections of enlarged heart, "he was of a melancholy temperament, of a slow and sedentary life, oppressed by misfortunes, and struggling with vexations and grief." In the angina pectoris, which is in its first attack no organic disease, we often find the dilated heart pale and tender, so that the fingers may be pushed through its flesh.

While the heart gradually enlarges, the system changes, and accommodates itself to its powers. There is little distress; often we find a heart enlarged to a degree such as we never could have suspected before death. But slowly there is formed such an accumulation of ill oxydated blood as oppresses the vital powers, and chokes the motions of the heart, and draws after it those other disorders which are already in part explained.

Of the mechanial consequences which follow the enlarged heart, those chiefly attract our attention which prevent the due oxydation of the blood.

First, The dilatation of the heart draws after it a dilatation of the great veins, so that they become reservoirs as it were; and the auricle and veins both enlarge

enlarge so, that the office of the auricular valves is quite lost; the veins feel, or rather the column of blood in the veins feels the back stroke from the heart, and it is perceived even in the neck by a strong pulsation.—Secondly, These veins, and this monstrous heart, so fill the chest, prevent the blood of the neck descending, and so push aside the lungs, as to compress them to the last degree that is consistent with life.—Thirdly, The enlarged heart accumulates much blood in the system which before did not exist, and that blood dark coloured and unfit for the purposes of life. The proportion betwixt the great mass of ill oxydated blood lingering in the veins and about the heart, is increased so very greatly, in opposition to the very small quantity which can now be oxydated in the lungs, that such persons are exposed every moment to the greatest dangers; and the least accident which draws out more black blood from the veins, and hurries it towards the heart, quite overcomes them. Then there is an agonizing and fearful struggle; the heart often struggles, and often frees itself; but in most cases those who live in this condition do, after many escapes, fall down suddenly dead. "A very learned man having this enlargement of the heart while he was still walking about in his ordinary health, his heart would often stop for three or four pulsations, as if struggling with its load, velutque expulsionem moliretur*."—Fourthly, In this enlargement of the heart, although sometimes there is a perfect and equal pulse, though sometimes also the disease scarcely shows itself till very far

* Vesalii, lib. i. cap. v.

advanced,

advanced, and after many years of slow increase; yet the heart being continually loaded, and often struggling, cannot free itself at one stroke of all its blood; then, stroke succeeding stroke in a confused irregular way, there is a weak, irregular, intermitting, fluttering pulse.—Fifthly, But Nature, wonderful in her ways, sometimes finds relief from this in the regular constitution of these parts; for while the heart dilates, and becomes more powerless as it dilates, the aorta (being but poorly filled) contracts in proportion as the heart dilates, and accommodates itself to the small quantity of blood which such a heart can give out; and thence the wonder sometimes expressed at finding an aorta extremely slender joined often to an enormous heart.

" In opening the body of a shoemaker, says Morgagni, whose heart was wonderfully enlarged, seeming as if you had joined two hearts, what chiefly struck us was the smallness of the aorta, more suitable to a delicate woman than to a man of good stature as this was. The aorta, from its passing under the diaphragm to its great division in the pelvis, was very small. This Morgagni first of all believed was owing to some stricture at the diaphragm; for the aorta did not pass as usual under the legs of the diaphragm, it passed through a peculiar hole; but he found this tendinous hole quite large and free. Still he believed that all the disorder of the heart arose from the contraction of the aorta, and that again from the crooked posture in which those sit who are of this trade. But that often the artery is contracted in favour of the enlarged ventricle, I am able to prove better than by this case of Mor-

gagni's. In the first place, the distorted posture of his shoemaker can have no effect; for we must not forget how limber, flexible, and free from disease, the aorta is in those who have the unhappiness to be deformed, and in whom the aorta follows the spine so closely, that often the bones almost meet in their distortions, and hide it. I have cut out these aorta sometimes and laid them on boards, to show the strange angles which they make with such perfect safety. Next I have to observe, that where the auricles and ventricles dilate in old people, the aorta also dilates: for there the aorta is old, partly ossified; its muscular coat stiff and incapable of action; it is, in short, as weak as the heart itself, and yields along with it to the accumulating blood. But in younger men, the aorta being muscular and strongly contractile, this phenomenon ensues: that as the heart increases in size and weakness every day, it struggles with less effect against the accumulation; its pulses are imperfect; it delivers less blood into the aorta; the aorta, less perfectly filled, is not excited by the same power which formerly filled it and kept it full: therefore it contracts gradually and slowly; it preserves still its healthy constitution; it is limber, pliant, and sound, in its muscular coat. In short, this doctrine of Morgagni's implies only a stationary condition of the aorta; this other theory implies an active contraction. Now Morgagni's shoemaker was a portly man, but his aorta was smaller than a woman's. Even this case of his own implies an actual contraction; since, had this man's aorta continued stationary, it must have been still the aorta of a man of good stature, joined

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to a large heart. But a perfect proof is this: I have a heart which it would not be easy to describe; it is not only as big as two hearts joined, but I may say, with Bartholine, "ut sæpe in Bobus non magis sit aut ponderosior." The heart is bigger actually than an ox's; it is bigger, I think, by the whole size of its two great auricles; it is injected with wax; it weighs more than four pounds, and is two feet in circumference; but the aorta is no bigger than the femoral artery at the groin, very straight and even in its diameter, very slender, and with coats which plainly have been very thin and suitable to such an artery. Here the artery is equably and fairly contracted to one fourth of its natural size, which supposes a natural and sound condition of its coats: And one of two things must have happened, either the artery must have contracted first, opposing the heart and causing it to enlarge; but then its violent contraction, like the urethra contracting in opposition to the bladder, would have thickened it into a strong muscular tube: or, secondly, the artery must have contracted gently and gradually in favour of the dilatation and weakness of the heart; and then it would remain (as this artery really was) very soft, delicate, and limber; in short quite natural. I suspect also that where the aorta is enlarged, there is required a strong, small, and muscular heart; because I have an aorta enlarged to a very great degree the heart being extremely small. These accidents will be noticed chiefly where, in young people, there happens such disproportion of muscular power betwixt the heart and its vessels; but in the aged, all the parts are but

too much disposed to disease, and the whole will enlarge.

These, then, are the chief consequences of that enlargement of the heart which often so fills the thorax and loads the diaphragm, that it falls down under the weight of the heart; then the heart is felt lower than natural; and the disorder is named by most authors the prolapsus cordis. In a young man of twenty years of age, the most miserable creature I ever saw, I have felt a prodigious heart beating as if quite in the abdomen: at the pit of the stomach the pulsation was particularly strong; it must have been mistaken for an aneurism of the cœliac artery, had not the heart been felt beating from the navel almost to the collar-bone.

Whether we are to allow, that the blood sometimes does coagulate and form polypi in those enlarged hearts, I believe no man in the present state of our knowledge will venture to decide. That the blood should coagulate thus firmly, while within the body, and that not in a corner of the circulating system but in the heart itself, where always there must be some motion, it is not easy to believe; nor that such coagulations should remain there, be washed pure by the current of blood, so as to have a leathery colour, and to be firm and strong; that such coagula should entangle the valves and columnæ carneæ, shoot up into the great vessels, and hinder the movements, and close, in some degree, the openings of the heart, is quite unlikely: yet if there be such a thing, this must stand as the description of a polypus of the heart. I incline then rather to the opinion of the able and

diligent

diligent Kerkringius, who calls them pseudo-polypi, bastard polypi, mere clots of blood; of which he produces drawings from the pulmonic veins, the liver, the heart, the brain, &c. wherever great veins are.

That when the heart is monstrously dilated, clots may be formed in it, very large, filling all its cavity, but still happening chiefly in the moment of death, or during its slow approaches, I believe from what Vesalius relates; who, "in the heart of a nobleman, found two pounds of a dark coloured flesh; upon which lump, the heart, of monstrous size, was extended like a gravid uterus." But this black flesh, since it was unconnected with the walls of the heart, was a mere clot; which, had it come really from the womb, Vesalius would have called a false pregnancy, an ovum deforme, or what the vulgar call a mole.

This, and all the lesser polypi, those strings of coagulum which entangle the columnæ, and stretch upwards into the vessels, are really formed in the moment of death. But it is not to be forgotten, that many of the most eminent men have thought quite the reverse of all this. Polypi, when first noticed, seemed a strange and awful and frequent cause of death. Having once believed and wondered at such a thing, people did not even like to be disabused; and when Kerkringius called them pseudo-polypi, the whole physicians, like a hive of bees, swarmed out upon him at once. Tulpius, Malpighi, Pechlinus, ridiculed this opinion. Pechlinus was so offended, that he could not refrain himself from low and mean language. "True polypi there certainly are, says he, but these

polypi of Kerkringius are indeed pseudo-polypi, and every blind shaver knows them abundantly well;" (tam est vulgaris et lippis tonsoribus notus). "The shop-boys, says Pechlinus, make such polypi, by pouring vitriolic acid into the veins." Yet with all his bitterness, Pechlinus has not proved, to my satisfaction, either by his arguments, or by his cases, that polypi exist: but he made many believe him, for the ignorance of that time is very singular. Dr. Petrus Russe tells us, that he had once found a polypus in the longitudinal sinus of the dura mater, of a quarter of a yard long: "Let this be put down," says he, "as one proof at least that polypi are sometimes found higher than the nose." What must have been the confusion of their notions, who could thus jumble the ideas of a polypus of the blood-vessels and a polypus of the nose?

They even mistook such clots for living animals. Dr. Edward May sent from England to the celebrated Severinus a description of an Eel which he had found in the cavity of the heart. He entitles it, with some propriety, "Historia mirabilis anguis bifidi." It is, indeed, a wonderful story; they describe head and tail, and all fairly, as if it had been *bona fide* a living creature, and tell us how its head was sticking to the inside of the heart (where you may suppose it was biting), and how its body was very white and very strong, and its arms or tails, I do not know what to call them, red. But what amuses one most of all is the important air of these communications betwixt Severinus and Dr. May; and then Severinus, warning his pupils against incredulity, and telling them, "that

though

though wounds of the heart are really mortal, yet ulcers of the heart certainly are not mortal;" by which he means, that while the Eel was alive it was continually biting the heart*. In short, from these things, we perceive that we need not look into books for any satisfaction on this delicate point; that we must depend upon ourselves, and make a better use of all future occasions; for unhappily there are no good histories attached to those dissections in which the coagula have been likest to those of a long formed disease†.

The heart, which is so often dilated by weakness, is sometimes reduced in size by an increase of strength and action. It becomes dense, firm, thick in substance, but small in its cavity; it appears to be dilated without, but is, in fact, contracted within. This thickening of the walls of the ventricles is what I cannot understand, though I have cut many such hearts with the utmost care. There is no ossification of the valves, no straitening of the aorta, nor any other obstruction to excite the heart. There is no enlargement of the auricles, no dilatation of the veins, no disease of the arteries, nothing appears but a thickening, and enlargement, and condensation of the walls

* It is certain enough that small worms are found not only in the œsophagus, but in the aorta too, of Dogs and other animals. Vid. Morgagni's *Adversaria*. For plenty of real worms in the heart, producing St, Vitus's dance in boys and hysterics in girls, vid. *Sckenkius*, page 272.

† A case liker this disease than almost any other, is a very melancholy and affecting story of a Mr. Holder, an apothecary. Vid. *London Medical Journal* by Simmons, and *London Medical Communications*.

of the ventricles, a proportionate enlargement of the columnæ carneæ, and a proportionate narrowing of the cavity of the heart itself. Upon opening such a heart, one would almost pronounce it natural. If one should speculate upon its peculiarities, he would (finding the heart strengthened, and its valves and vessels all sound) pronounce that it would cause rather a vigorous circulation and strong health: yet I shall never forget the miseries I have seen patients endure from having such a heart. They have often a full and bloated habit of body (at least so I have chanced to observe), a pulse weak at all times, but trembling, and hardly sensible, when a fit of difficult circulation approaches; then the pulse vanishes, the patient sometimes faints; the anxieties, oppressed breathing, languid pulse, actual faintings, and all the intermediate conditions less than fainting, but like it, and infinitely more miserable, make their chief sufferings. After struggling long under this disease, the patients grow languid for a few days, often become dropsical, and then die.

The variety of symptoms which those suffer who have this simplest of all the diseases of the heart is very surprising, and puts to nought all our conjectures about certain signs indicating particular diseases of the heart. We cannot be surprized that in great enlargements of the auricles, or vast aneurisms of the aorta, or in those enlargements in which something like polypi are found, and where, as Mr. Holder often said of himself, the circulation seems to go on for a time in one corner, as it were, of the heart; in all such cases, we cannot wonder at there being heard noises

like

like the rushing of water. But how such should be heard in this thickening of the heart, I cannot conceive: yet it is certain that one gentleman, whose disease came upon him all at once, and while perfectly at rest, with the sudden sense of something bursting within; who had moreover for several years a palpitation which could be felt outwardly, and a plunging noise, which at times the by-standers could hear very loud; who died in the end in great distress,—had yet none of these ossified valves, enlarged aorta, nor other organic affections, which there was so much reason to suppose, but merely this thickening of the substance of the heart.

Among the diseases of the heart we may reckon the dilatation of the aorta, a disease more frequent than all the others, and more dreadful. It is a disease more frequent in the decline of life; it is then a disease of weakness; it arises from a cause quite different from that which is commonly laid down. The celebrated Dr. Hunter believes that it arises from that predisposition or weakness which naturally belongs to the form of this part, viz. a sudden angle of the artery, exposed in the most direct manner to the whole force of the heart. Dr. Hunter also believed, that no sooner is Nature sensible of this danger, than she seeks to prop up the artery; and for this end thickens its walls till it ossifies by slow degrees. Haller's theory is different from this, and comes nearer to the truth; for he makes these scales of ossification not the consequence, but the cause of the disease. He says, the artery becoming scaly, and partly ossified, no longer yields to the force of the heart; and the heart thus excited

excited to a higher action is itself dilated, and at last forces also the aorta. In truth, neither of these is the true theory; but the aorta in aged persons beginning to ossify, has its middle or muscular coat annihilated, and its outer and inner coats thickened, by the same process. Its muscular power is lost; it is no longer capable of withstanding, much less of seconding, the stroke of the heart by a second stroke; it ceases to act, suffers itself to be dilated, and in a few years grows into a dreadful disease. I never saw an old aorta without some specks of ossification, or rather of calcareous concretion, nor an aorta so affected which was not dilated in proportion pretty nearly to the degree of this thickening and ossification; at which we need not wonder, since we find not a bone (as it is usually called ossified aorta), but a vile calcareous concretion substituted to its muscular coat. Nature is not at this time, as Hunter supposed, building up and strengthening the walls of the aorta against this disease; but taking down slowly that fabric which has lasted its appointed time.

However produced, it is an awful disease; for every organ, when once deranged, especially if it be one as active as this is, never stops in its course; and this especially ends early or late in some terrible kind of death. Sometimes, increasing in size, it destroys all the surrounding parts and bursts within. Sometimes it bursts into the chest, and then the patient drops suddenly drown; sometimes into the trachea, and then the cause of the sudden death is known: for the patient, after violent coughings and ejections of blood by the mouth, expires. Sometimes it beats its

its way through the ribs, destroys the vertebræ, affects the spinal marrow; and thus the patient dies a less violent or sudden death. Most frequently, the tumour rises towards the root of the neck, is felt beating there, destroys the sternum, bursts up the ribs, dislocates and throws aside the clavicles, appears at last in the form of a great tumour upon the breast, beating awfully.—A dreadful state! and with nothing to keep in the blood but a thin covering of livid skin, which grows continually thinner, till, bursting at last, the patient expires in one gush of blood.

But Nature can seldom bear all this distress; the patient dies before this awful scene commences; for the aorta often so fills the chest, so oppresses the lungs, chokes the tracheæ, and curbs the course of the descending blood, that the system, with a poor circulation of ill-oxydated blood, is quite exhausted! And thus, though the patient is saved from the most terrible scene of all, he suffers great miseries: he feels sharp pains passing across his chest, which he compares with the stabbing of knives and swords; terrible palpitations; often an awful sense of sinking within him; the sound within his breast as if of rushing waters; a continual sense of his condition; sudden startings during the night, and fearful dreams, and dangers of suffocation; until with sleepless nights, and miserable thoughts by day, and the gradual failing of an ill-supported system, he grows weak, dropsical, and expires.

How, except by attributing them to some peculiar weakness, to some inward predisposing cause, shall we account

account for all these terrible diseases of the heart? Albertine ascribed them so entirely to the passions of the mind, that he gives this as the chief reason why in the lower animals * such accidents are not found. This is strange philosophy; for who does not know that the human passions are remarked only because they should be under continual restraint and controul? while those of animals pass thus unnoticed by Rammazini, only because they are wild and furious, and we do not expect that they should be restrained. The wild and ungovernable spirits of animals would produce such diseases surely, if such causes could; but whether they do produce them, neither Rammazini nor any of us know; we are too careless of this kind of dissection.

Often, as I have explained, these complaints lie dormant for years, till on some violent exertion the patient begins to feel them; and when questioned by his physicians, being himself also extremely anxious to recollect the cause, and always willing to satisfy his physician, he remembers some violent exertion, some paroxysm of passion, some fit of coughing, or something even less important than all this; and tells how from that day he does not think he has enjoyed an hour of health.

That these disorders will arise from too violent exertions, independent of all predisposition, we have every reason to believe. Sometimes from blows, more frequently from shocks or falls (for I have formerly

* Had Rammazini never seen a Dog enraged, nor a wild Bull, nor untamed Horse, nor a Cat with its back up?

noticed

noticed how little there is, except its vessels, to support the heart, or hang it within the chest); but most frequently of all have we reason to suspect those kind of exertions which are accompanied with a rapid pulse and hurried respiration. Of this kind I must surely reckon all exertions disproportioned to the strength, and most of all in the time of weakness and convalescence. Do we not observe how in scurvy, upon the smallest exertion, the men drop down dead? how when a ship is in danger, and they are pumping day and night with a weakly crew, these also fall down dead? Do we not often remember, that after fevers young Men, having made rash exertions during their state of weakness, have brought upon themselves this dreadful disease? Do we not see that boxers, horse-jockeys, and all the tribe of athletics, cannot make these exertions unprepared? And what is their course of training, but a spare diet of generous food, with regular exercise, and gradual exertions; till, at last, the two great functions of respiration and circulation accompanying each other, are brought to the highest pitch; and the man become capable of exertions, before impossible or dangerous; now familiar and easy to him? For examples of this danger, let these suffice: A delicate man, little accustomed to fatigue, having alighted from his horse and tied it carelessly, it escaped; and all day long he chased it, till, quite exhausted, he was forced in the evening to give over, breathless and palpitating, a hundred times during this vain pursuit. From that day he never had one moment's comfort. In about a year after two throbbing tumours appeared

upon

upon his breast; and, in the course of the second year when he came to me, these tumours covered all the breast, throbbing in a most alarming degree, each of them bigger than two fists. At this time he had walked with tolerable ease three miles to see me; but in less than four months he was dead, having lived in the greatest misery.

When I cut out the heart, I took also the sternum along with it. I found an aneurism of the aorta filling all the chest, two fair round holes betwixt the cartilages on each side of the sternum, by which the two tumours were filled; the ribs and sternum were not eroded, but the intervals betwixt the cartilages dilated; the two tumours were, when the sternum was cut away, like two great flat cups, cymbal-shaped, one a little larger than the other, and each capable of containing about a pound of blood.

It has been known to happen, that a young man, travelling on foot too far, has died in a few days of a prodigious enlargement, with pulsation of the heart. But the case which comes nearest to that which I have just related, is that of a man about 47 years of age, who had fallen into the hands of robbers. These men, unwilling to commit direct murder, carried him into an unfrequented place in the forest, and there tied him to a tree. Sensible that no human ear could hear his cries, he made the most violent struggles, but without success. At the distance of six hours he was found by a huntèr accidentally passing that way, and saved; but not long, for his struggles had produced an aneurism of the aorta, of which he died. Upon opening

his

his body there were found two aneurisms; one in the arch of the aorta, and one in the left subclavian artery.

The many cases in which aneurisms seem to proceed less directly from strains, blows, falls, and other mischances, I will not stop to explain; for a thousand such examples cannot prove that there did not exist an absolute predisposition in each individual case. But as I began with representing the marks of ill-oxydated blood in a child, I shall conclude with representing the condition of a man, which, even by a regular history, could not be represented more faithfully than in this single case.

I attended, says Morgagni, the most excellent Marquis Alloysis Pallucci, commander of the Pontifical forces at Rome; a man who deserved a longer and a happier life. His disease was an aneurism in the breast: he could neither lie down, nor go to stool, nor take nourishment, but almost instantly a paroxysm was brought on, which threatened instant suffocation, and sometimes seemed like death itself. He never went to bed; he continually rested on a chair to avoid all motion; but instantly upon the attack of difficult circulation, he would leap from his seat, and run to the open window, in hopes of breathing there more freely: yet even there he was used to draw his breath with a stertor, his face was quite livid, he passed his urine and feces without consciousness; often the breathing was so very difficult, so interrupted, that even the snoring ceased, and he seemed dead, and fell forwards, apparently lifeless, into the arms of the two servants, who continually supported him on either hand. This was the degree of his distress.

But

But after all these dreadful reports of diseased heart, must it not be a comfort for us all to know, that often the most simple affections, such as we call nervous, from peculiarity of constitution, or from ill health, resemble these organic diseases, so that all the physicians on earth could not pronounce upon the case? In short, often those which appear to be at first the most awful diseases, turn out in truth the most trivial and temporary. Palpitations and quick breathing are the most usual signs. Palpitations, says Sckenkius, may arise from tubercles, abscesses, or congestions of blood; from worms, from stones in the heart, from poisons. But why distress us with the catalogue of these and many other horrible things, till first he have explained palpitation to us as a common but merely nervous disease, which many feel but few complain of?

Were a man to study only these examples of organic disease, he must of course believe that there were no other, and think that every palpitation portended death; while palpitation is, in truth, the nervous disease of boys and girls, of women, or of weakly men: it alarms the young and the robust; while, in fact, organic disease belongs rather to advanced life, and comes seriously upon us at a time when all fears about palpitations are past and over.

I like what Galen says (Lib. de Loc. Affect. cap. ii.) "Palpitatio visceris hujus, pluribus integra valitudine degentibus, cum adolescentibus tum adultis, subito, sine ullo alio manifesto accidente, evenire visa est." I think it dangerous to add what follows; "atque omnes eos sanguinis detractio juvit;" for I know such bleeding to be but a temporary relief, more than coun-terbalanced

terbalanced by a permanent loss. This text I shall explain a very little, and then conclude: for palpitation is, indeed, the disease of boys and of young men, as I have just explained, but not of the aged, in whom chiefly we find organic disease.

Palpitation is like that fluttering which fear brings on; the heart rises in its action till it throbs, and beats against the ribs; it is strongly felt, it is even audible to the by-standers, and still it is but a nervous disease. Its intermissions usually distinguish it from any organic disease; its paroxysms last for many days or weeks; and for weeks or months again it goes quite away. We see it relieved by a jaunt, by living from home and in company, by leaving all business and thoughts of business quite behind: we see the causes which bring it on as plainly as we know the cause of marsh fever, or the plague. The confinement even of a boil will cause it; the confinement of severe study is sure to cause it; and severe study, with an anxious mind, in a young man unused to study; neglected where he is, and at a distance from all his friends, are sure to produce this distress. "My son," says Wierius, "while at Bologna pursuing his studies, had this afflicting palpitation, accompanied with a capricious, frequent, and intermitting pulse; but by bleeding (which the older physicians never neglected,) and care and relaxation from his studies, he got quite well." This is the palpitation which the older authors distinguished by the name of palpitatio cardiaca, marking it as proceeding from the stomach; equivalent, in the language of the present time, to the calling it a nervous disease.

 These,

These, then, are the habits, in which it occurs, and this its cause: and there remains but two things to be shortly observed, or rather to be proved, viz. that it is sometimes as alarming as an organic disease is; and that bleeding is dangerous is an extreme degree, or at least that it does not, as Galen affirms, "always bring relief."

"Sanctius Velasco, son of the Count Velasco, had a palpitation of the heart so terrible, that I and many by-standers often heard it distinctly, at if a stone had been plumped into a jug half full of water.*" Yet this boy got entirely well, and his physicians made themselves very happy in the thought that they had cured him, by a sacculus of aromatic herbs steeped in wine applied to the region of his heart; and by the same aromatics, or cardiacs as they called them, given along with his food.

I prove the second point, viz. the danger of bleeding, by a most alarming case, delivered by Morgagni, which I fear might (if it had so pleased the writers) have had in the records of medicine many precedents; it wholly destroys the authority of Galen's rule, and plainly instructs us never to bleed. "A boarding-mistress, having a slighter palpitation of the heart, was bled with some appearance of relief: but after two days her palpitations returned with such violence, that the breast seemed at every stroke to be lifted up; she had withal pain, fever, and difficult breathing. They continued bleeding her first in the arm, which did no good; then in the foot which was absolutely fatal;

* Christoph. a Vegas *Ars Medendi*, lib. iii. sect. 6. cap. 8.

for

for in an hour after she died, the pulse becoming quicker instantly, and falling gradually lower and lower, and giving less resistance to the finger till she expired." In her viscera both of the belly and of the thorax, every thing was entire, sound and natural; and it had been well for the physicians who attended her, had they remembered that the very name of palpitatio cardiaca implies a course of proceeding quite the reverse of this.

Thus the simple disease of nervous palpitation is often ill understood, and the patient's health abused and his miseries and agony of mind, and his real disease, all increased, by the serious looks of his physicians, when, perhaps, it is but a very simple case.

The French physicians, in a very formal consultation, made a very public mistake of this kind, in the disease of Marinus de Caballis, ambassador at Paris from the Venetian State. He complained to them of his palpitation, and of his intermitting pulse, and they concealing nothing of their opinion from him, prognosticated the very worst; advised him to demand his audience of leave, to go off for his native country, and there to make his will, settle all the affairs of his family, and then compose himself for his last hour. Having obeyed them in all things, he arrived in Italy very disconsolate and dejected, and their prognostic was well nigh fulfilled. But, like a man who would have another throw for one precious stake, he called a consultation of the college; among whom, happily, was Victor Trincavelli, then professor in the university of Pavia; who, perceiving that such tremors of his pulse proceeded entirely from the great charge of important matters

which lay heavy upon his mind, assured him of recovering his health. He ordered frequent bleedings, which the peculiar fullness of his habit seemed to require; and by cordial medicines he was entirely restored, and lived long;—a man of great science, and skilful in many languages. After this sad journey, he performed with much honour to the state two splendid embassies to the Emperor and to the Turks.

Let no one in future pronounce so rashly; it is time alone, and various modes of living, that can explain to us whether there be in any individual case a fixed disease. Nor would I dare to speak of the organic diseases of the heart, without explaining more fully an idea which Albertine has shortly and simply expressed. "Formerly, in diseased respiration, any vitiated structure of the heart and precordia were unheard of; but after observations being several times repeated in dead bodies, the same names are too much heard of and too much dreaded in the living.

# BOOK II.

# OF THE ARTERIES.

## GENERAL PLAN OF THE ARTERIES.

### AORTA.

THE arteries of all the body, (excepting only those of the lungs employed merely in oxydating the blood) arise from one trunk, the aorta; which we must describe as of great size, since we compare it with other arteries, but which is wonderfully small, considering that it is of its branches only that the whole body is composed.

Those will have the truest notion of the distorted form of the aorta who have studied the anatomy of the heart. Its root is deep buried in the flesh of the heart. In the Tortoise we see the flesh of the heart rising round the root of the aorta, and endowing it

with the power of a second ventricle: in the Frog we find its internal surface beset with a triple row of valves, and its coats are like those of a ventricle, they are so exceedingly strong: In Man we find it plainly muscular, surrounded in circles with great fibres, and having much muscular power.

The beginning of the aorta, then, lies deep in the flesh of the heart; it is there that it gives off its coronary arteries; it bulges at its root into three great knobs, which mark the place of its three valves, and are called the lesser sinuses of the aorta; it is large at the root, it grows smaller as it rises, it mounts upwards and backwards from the heart, till it begins to form its arch or curvature; its direction is first towards the right side of the thorax; looking backwards, it turns in a very distorted manner, where it forms the arch; it strides over the root of the lungs, going now to the left side and backward, till it touches the spine; its arch lies so upon the forking of the treachea, that its aneurisms often burst into the lungs: it then applies itself close to the spine, so that in aneurisms the pressure of the aorta often destroys the vertebræ; and now lying along the left side of the spine, and with the œsophagus running close by it, it passes down through the thorax, and from that to the belly under the legs of the diaphragm.

This, then, may serve as a short description of the aorta, which is the root of all those arteries which we proceed now to explain. Its structure is strong, muscular, and continually active, performing the office of a second heart. When in old age it begins to lose this muscular power, to have its fibres embarrassed with

chalky,

chalky, or as they are called bony concretions, it is no longer able to resist the force of the blood; it is not dilated into aneurisms, because of the acute angle which it makes, and the direct impetus of the blood, for many other arteries turn backwards with very acute angles; the arteries tied in aneurisms, amputations, and on other occasions, do not dilate; the inosculations which save a limb after the operations for aneurism, receive the blood in a retrograde course, and the angles are often very acute, yet they do not dilate too much. The arteries under joints are oftener bent than straight: the aorta of deformed people follows closely the deformity of the spine, and makes such singular angles that after once seeing them no one will talk of angles occasioning dilatation. The aorta, when dilated, in nine of ten cases is covered with white spots; it is diseased; they are aged people, and almost always the dilatation begins from the heart.

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The aorta, then, is the trunk from which the general tree of the arteries is to be explained.

From the arch of the aorta go off three great arteries, which rise to the head, or bend sidewise towards the arms, and so nourish all the upper parts of the body. Of these three arteries, the first is a great one, which contains, if I may so express it, the RIGHT CAROTID and the RIGHT SUBCLAVIAN, and divides so as to form those two arteries, about one inch after it arises from the arch; the next is the LEFT CAROTID ARTERY going to the head; the third is the LEFT SUBCLAVIAN, going to the left arm. These three branches occupy all the arch of the aorta.

## RIGHT SUBCLAVIAN.

The right subclavian goes off from the aorta in a more direct course than the left; it is thought to receive the blood more fully; perhaps, also, it is rather larger than the left subclavian: but, at all events, there is something peculiar in the mechanism of the right arm; most probably it is the peculiar form or direction of this artery that gives to the right arm a superior dexterity and strength. When Horses are to be broken, we find the chief difficulty to consist in teaching them to move equally with both feet, for they prefer the right; when a Dog trots, or when he digs the ground, he goes with his right side foremost, and digs chiefly with his right foot; and in these creatures we find the same arrangement of these arteries as in ourselves. When we lose our arm, the left hand acquires by use all the strength and dexterity of the right. Since, then, either arm can acquire this dexterity, and since the right leg is stronger by its dependence upon the motions of the right hand, we have every reason to believe, that the preference given to the right hand has some physical cause, and that it is the peculiar form of this artery, viz. going off more directly on the right side, and that those who are ambidexter must have the right as well as the left subclavian going off as one independent branch.

There is another peculiarity which has occurred. The arch sometimes gives out four branches, and the left subclavian, arising first from the arch, has passed behind the trachea, betwixt the trachea and the œsophagus. The

The subject dying of difficult deglutition, which has subsisted from childhood, it has been attributed to the pressure of this preternatural artery, an effect which I cannot easily believe; and it has been proposed to rank it as a new and certainly incurable species of the disease, under the title of dysphagia lusoria, as arising from a lusus naturæ of this artery.

## CAROTIDS.

THE next branch of the arch is the LEFT CAROTID. The two carotids mount along the sides of the neck, are felt beating strongly, and seem much exposed. They retire for protection behind the prominency of the thyroid cartilage. They divide into external and internal carotids under the angle of the jaw. The EXTERNAL CAROTID supplies the neck, the face, the inside of the throat; and the reader will have chiefly to observe its course all along the neck, its branching at the angle of the jaw, and the operations and wounds about the throat, neck, face, and especially about the root of the ear.

## LEFT SUBCLAVIAN.

THE left subclavian is the third branch of the aorta. Each subclavian artery varies its name according to the parts through which it goes. This great artery of the arm is named SUBCLAVIAN under the clavicle, where it gives branches to the neck; AXILLARY in the arm-pit, where it gives branches on the one hand to the scapula, on the other to the breast. It is named BRACHIAL where it runs down the arm, and where there

there are few important branches; and, finally, its branches, into which it divides at the bend of the arm, are named RADIAL, ULNAR, and INTEROSSEOUS, because they respectively run along these parts, the radius, the ulna, and the interosseous membrane.

### THORACIC AND ABDOMINAL AORTA.

THE aorta, after completing its arch, passes through the thorax, giving but few branches, and those very slender. But the ABDOMINAL AORTA, as soon as it has emereged from under the legs of the diaphragm, gives three great abdominal arteries: First the CÆLIAC, going in three branches to the liver, the stomach, and the spleen; secondly, the SUPERIOR MESENTERIC, which furnishes all the small intestines; and, thirdly, the LOWER MESENTERIC, which supplies most of the great intestines down to the rectum. The arteries of the kidneys and of the testicles follow these, and then the aorta divides into two great branches for the pelvis and legs.

The ILIAC ARTERIES are the two great branches into which the aorta divides within the abdomen, and these again are each subdivided into two great arteries; the INTERNAL ILIACS to supply the pelvis, the EXTERNAL ILIACS to go to the thigh.

### INTERNAL ILIACS.

THE INTERNAL ILIAC supplies the bladder, the rectum, the womb, with lesser arteries; but its great arteries go out by the openings of the pelvis to supply the very large muscles of the hip and thigh. Thus the

the GLUTÆAL, a very great artery, turns round the bone, goes out by the sciatic notch, and goes to the glutæal muscles. The SCIATIC, almost equally large, turns down along the hip opposite to the glutæal, which turns up. The pudic, of great size, also turns out of the pelvis, turns inwards again towards the root of the penis, and belongs entirely to the private parts, as its name implies.

### EXTERNAL ILIACS.

THE EXTERNAL ILIAC, when it passes out of the abdomen, takes the name of FEMORAL ARTERY: it divides into two vast arteries a little below the ligament of the thigh: the one goes deep, belongs to the muscles, is called the PROFUNDA; it furnishes all the thigh, and it might with the strictest propriety be named the femoral artery. The FEMORAL ARTERY, as we call it, is the other great branch, which continues superficial, runs obliquely down the fore part of the thigh, gives few and but trivial branches to the thigh, and is really destined for the leg. When the artery turns inwards towards the ham, it is named POPLITEAL ARTERY; and, like the artery at the bend of the arm, this one at the bending of the knee divides into three great branches, which, like those of the arm, take their names from the bones along which they run; the ANTERIOR TIBIAL ARTERY lies on the fore part of the tibia; the POSTERIOR TIBIAL ARTERY runs along the back part of the tibia; the FIBULAR ARTERY runs along the fibula; and these great arteries terminate by making arches with each other in the sole of the foot, in the

same

same manner that the RADIAL and ULNAR ARTERIES join in great arches in the palm of the hand.

This slight plan I have chosen to throw out before my reader, that the succeeding parts may seem more methodical, and that he may have at a slight glance the chief parts of his task before him; and knowing all his duty, he cannot be inattentive to that on which the lives of his fellow-creatures must so often depend.

## CHAP. I.

## OF THE ARTERIES OF THE HEAD.

### SECT. I.

#### OF THE CAROTID ARTERIES IN GENERAL.

THE carotid arteries are also named the Arteriæ Cerebri, as if they were the sole arteries of the brain; and the ancients, either ignorant or forgetful of there being any other arteries for the brain, or not observing that

that the vertebral arteries might convey blood enough for the functions of the brain, did actually name the carotids the Arteriæ Soporiferæ; believing that, if they were tied, the person must fall asleep *. How a person might die from having the great arteries of the head tied, I can most readily conceive; but how he should rather fall asleep, and not die, is quite beyond my comprehension: and yet many of the best anatomists, in the best age of anatomy, have abused their time repeating these experiments. Vasalva, Van Swieten, Pechlinus, Lower and especially Drellincartius in his Experimenta Canicidia, and many others, spent days and weeks in tying up the carotids of Dogs. What does all this imply? Surely a strong belief in tales which would disgrace the Arabian Nights; tales concerning a manner of tying a cord round the neck of a She-goat, or even of a young Man, so that, without hurting them, they should be made to sleep or wake, according to the bidding of the spectators.

Costæus first tells this tale: "Circumforaneous mountebanks (says he †) often perform this miracle. They tie a ligature round the jugular veins of a She-goat; and they tighten it and relax it from time to time, so that at their pleasure the animal falls down motionless and stupid, and at their bidding leaps up again with great vigour." The most incre-

* The name which we use, viz. that of carotids, is synonymous in Greek with Arteriæ Soporales.

† Disquisitiones Pathologicæ, lib. 6. cap. 6.

dible tales soon followed, and soon crept into otherwise good and useful books. Even Hoffman seems not unwilling to believe that the Assyrians had been in the use of tying up the jugular veins in their young men before circumcision, that they might feel less pain. A serious operation, God-wot! for so slight a cause. Even Morgagni talks more seriously of the She-goat, and of this snibbing of the young men of Assyria, than one could wish in respect to the character of one so truly great as Morgagni *. But the person the most celebrated in this affair was Realdus Columbus; and the wildest and most barefaced tale that ever was told, is that delivered by his pupil Valverdus in his Anatomy of the Human Body.

" The carotid arteries (says Valverdus) being tied up, or any how obstructed, the person grows stupid and falls presently into a profound sleep. This experiment I saw at Pisa in the year 1554. It was performed upon a young man by the celebrated

* The celebrated Cant not only believes this most powerfully, but reasons upon it in the following manner: " Ruffus Ephesius, lib. 1. cap. 34. hanc soporem adferre negat, hinc aliud nomen permitteret; sed Realdus Columbus publice in theatro demonstravit hunc effectum præstari hac arteria: itaque nomen retinebimus, UTPOTE rei CONGRUENS. Sic enim quotidie experimur post prandium somnolentiam, quam facile deducere possumus ab effectu hujus arteriæ; nam ventriculo extenso premitur aorta descendens, quo sanguis copia majori ruit in carotides; quæ hinc extensæ comprimunt cerebrum quodammodo, quo motus animales non ita expedite absolvuntur, verum vitales augentur motus, quæ ambo siunt in somno." *Tab. Cant impetus faciens*, p. 6.

Columbus

Columbus in the presence of a great many gentlemen and strangers, with no less misery to them than amusement to us (the pupils), who, though we knew the cause, ascribed it altogether to the black art." But if any one word of this were true, Valverdus would have told us, and been proud to tell us, by what particular operation, ligature, or pressure, this strange thing was performed; and Columbus himself, the author of this new amusement, would surely have dropped some hints about it in some place or other of his works. But from the modest silence of the master, and the secresy of the pupil, we have reason to believe it is untrue; and if Columbus did ever venture to exhibit such a mean piece of legerdemain, he put himself quite upon the level with the quack and his She-goat. The quack, indeed, was much beyond him in point of merit, since it must have been far easier to teach a clever young Man to fall down or start up than to teach all this to a She-goat.

Galen has explained it well, saying, "that physicians and philosophers, tying the carotid arteries, tie in along with them the recurrent nerves which serve for the voice; and if they will have silence to be sleep, no doubt the creature is mute after their awkward operation; but no other function is hurt neither then nor afterwards."

This is the truth, and the whole truth nearly; for if but one Dog lives after both carotids are tied, nothing can be more certain than that those which die must have suffered by some awkwardness or disease. Is it wonderful that, after such a cruel tedious operation as this is, the Dog should be exhausted, should be weakened

weakened by loss of blood, should feel sore, and hang his head and droop, and let the slaver fall from his jaws? that he should skulk in corners, look sidelong, be jealous, and not easily moved from his hole? These are what they have thought fit to call drowsiness and signs of sleep; but it is such drowsiness and such sleep as would have followed such a cutting-up of the creature's neck, whether the experiment-maker had touched the carotids or not. The creature lolls its tongue, hangs its head, closes its watery and heavy eyes, is drowsy, or, in other words, feverish for many days: It eats with all the voracity of a Dog, but with difficulty, and slowly, owing to the swelling of its throat; and if it dies, it dies from the same cause. Nothing is more certain than that these are the only particular effects, and that the carotids of a Dog may be tied without any other danger than that of the wound.

There is nothing new under the sun. We are continually tantalized with old tales in new forms. Who would expect to find at this very day a practical application of the She-goat and the Assyrian young Men? One author has published to the world, "that a young Lady, of a nervous and delicate constitution, subject to nervous distresses in a wonderful variety of forms, but more especially in the head, sometimes afflicted with headachs, sometimes with delirium, sometimes with convulsions, was relieved by compressing the carotid arteries." Often by compressing the carotid arteries, this gentleman prevented the delirium; "for all these complaints proceeded from a violent palpitation of the heart with the stream of blood rushing violently towards the head." He has seen this compression bring

on

on a stupor; he has seen it bring on a profound sleep. Is it not a pity that he had not attended more to the history of this business, and joined to these facts the story of the She-goat and the young Men of Assyria?

If what Dr. Parry says be true, that in lean people, in women at least, we can, by reclining the head backwards, compress the carotids entirely against the forepart of the neck with the finger and thumb; why, then, we need have no fear of hemorrhagies of the nose, wounds about the jaw, cutting the parotid gland, or operations about the tonsils or tongue! But there is a dangerous mistake here; for there is (as I know by much experience) a wide difference betwixt preventing the pulse of an artery and suppressing the flow of blood through it. In the case of a Man fainting during any great operation, if you are holding in the blood with the point of your finger upon some great artery, you feel the pulse there, while the face is deadly pale, the extremities cold, and the pulse of the wrist and of all but the largest arteries gone. In fainting, even the heart itself is not felt to move: and yet it moves, and the blood circulates: how else could a person lie in a hysterical faint for hours, I had almost said days? I have tried, in great operations near the trunk of the body, to stop the blood with my hands; but though I could suppress the pulse of the femoral artery with my fore finger, I could not command its blood with the whole strength of my body, but have seen it with horror rush as freely as if my hand had not been there. In short, I suspect Dr. Parry's belief of his stopping the carotids with his finger and thumb is as

 vain

vain as Dr. Monro's expectation of compressing the abdominal aorta by pushing with his fist against the belly.

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THE CAROTID ARTERY, having emerged from the chest, runs up along the neck by the side of the trachea, a single undivided artery, without twig or branch, till it touches the jaw. The length of this artery gives us a fair opportunity of observing, of proving, if we choose, that arteries are cylinders, and not, as they once were supposed, of a conical form. But the cylindrical form of this artery should not occupy our attention so much, as that peculiarity of direction which, though apparently exposed, keeps it safe; or those important connections which make it so dangerous either to cut or to tie this artery.

First, The carotid artery, from the place where it emerges from the chest up to the angle of the jaw, is continually receding from the fore-part of the throat, is getting deeper and deeper by the side of the trachea, at last the strong projection of the larynx or cartilaginous part of the tube defends it; and when it has got to the angle of the jaw, it lies there so deep under the ear, betwixt the ear and the jaw, in a sort of axilla, as we may call it, filled with fat and glands, that it is almost out of reach of danger, unless it be sometimes of the surgeon's knife, but rarely of wounds.

This continual retreating of the carotid artery, deeper and deeper as it rises along the neck, saves it from the attempts of suicides: it is rarely cut, or when cut, it bleeds so that no ignorant person can command it,

and

and the surgeon is too late. But although tumours and aneurisms are rare, and through unwillingness and a well-grounded fear such patients are usually left to take their fate; yet there may happen cases in which it may be necessary to do so bold a thing as to tie this artery.

Secondly, The connections of the carotid, as it rises along the neck, must determine our judgment, if ever any such case should occur. To stop the growth of an aneurism, to allow the extirpation of other tumours about the jaw, to save a patient from dreadful bleedings of the throat, or from the hemorrhagies of deep wounds, when, for example, a patient is stabbed in the neck, or a ball passes through the mouth and under the angle of the jaw; these may, in some unlucky moment, present themselves as motives for tying the trunk of this artery, when all its great branches are torn. But always the observation of Galen is to be remembered, that the nerves accompanying these arteries are liable to be tied together with them.

Let us recollect how the carotid artery, jugular vein, and eighth pair of nerves, come out from the skull, for it is almost at one single point. The carotid artery enters by a hole in the petrous bone; the jugular vein comes out by a larger hole in the same bone, the foramen lacerum; immediately behind it the eighth pair of nerves, or the par vagum, goes out through a division of the same foramen lacerum, separated from the vein only by a little cross slip of the dura mater; and so the carotid artery, jugular vein, and eighth pair, touch each other at the basis of the skull. Through the whole length of the neck they continue the con-

nection which is thus early begun. They are, indeed, inclosed in one sheath of cellular membrane, so that what touches the one almost inevitably affects the other. The par vagum being the great nerve of the viscera, at least of the stomach, strictures upon it or wounds are certainly fatal. A surgeon might easily, if it were possible for him to be called in time, take up the gaping mouth of the artery safely when it were cut across; yet in most of such cases the nerve being also cut, the operation would be fruitless. But as for a deliberate dissection of the skin, the artery beating furiously, and the parts embarrassed with any tumour, and the operator alarmed with a deluge of blood from the veins: that, I think, would be a bold step. In short, the necessity of any such operation is reduced to the accident of tumours or wounds about the angle of the jaw; in which cases, the sponge thrust down into the wound will almost always check the blood.

When the common carotid has risen to the angle of the jaw, it divides into two great arteries, one going to the outside of the head, the other to the brain; the one of course named the EXTERNAL, the other the INTERNAL CAROTID. Some of the most eminent anatomists are incorrect when they say, that the carotid artery gives no branches till it arrives at the larynx. They say so because the first branch goes to the larynx; but, in fact, the carotid passes much beyond the place to which it is to give its first branch, for instead of branching at the larynx, it does not do so till it arrives at the corner of the jaw; there, as I have observed, it can, as in an axilla, lie deep and safe; and the laryngeal artery, which is the first branch of

branch of the carotid, turns downwards again to touch the larynx.

The first division, then, of the carotid artery is into the external and internal carotids; and the external carotid gives branches so interesting to the surgeon, yet so numerous, that it is at once very desirable and very difficult to get a knowledge of each: arrangement is here of more importance than in any order of arteries, though extremely useful in all.

## ARRANGEMENT OF THE BRANCHES OF THE EXTERNAL CAROTID ARTERY.

The external carotid gives three sets of arteries; each of which, having a plain and distinct character, cannot be forgotten, nor their direction, nor their uses, nor their relative importance, misconceived; for if we consider but the parts along which the carotid artery passes, as 1. The thyroid gland; 2. The tongue; 3. The face; 4. The pharynx; 5. The occiput; 6. The ear; 7. The inside of the jaws; 8. The temple:—if we remember thus the order of these parts, we shall not forget the order in which the branches go off.

But it will be further very useful to observe, that these many branches divide themselves most naturally into three sets.

1. The branches which go off from the carotid forwards are peculiarly important; one of them goes to the thyroid gland, another to the tongue, and a third to the face; parts which, to say no more, are

peculiarly exposed; but they are, besides, the subject of many particular operations.

2. Those branches which go backwards and inwards as the pharyngeal, the auricular, and the occipital arteries going to the ear, the pharynx and the occiput are both extremely small, and also run so deep, that wounds of them are rare and of less importance, and fortunately those branches are the only ones which it is difficult to remember.

3. The great artery which passes behind the lower jaw, named maxillary artery, and the temporal artery which lies behind the jaw, imbedded in the parotid gland, must be studied with particular care; the difficulty of cutting tumours here, the course of the temporal artery in which we bleed, and which, lying imbedded in the parotid gland, demonstrates the absurdity of talking about cutting out the parotid gland, since plainly it cannot be done; and lastly, the terrible hemorrhagies which often happen from the throat, nose, tonsils, &c. gives an importance to these two branches above almost any other. They should be very familiarly known to the surgeon.

These, then, are the three divisions of the external carotid artery which are to be described.

FIRST

## FIRST ORDER,

INCLUDING the arteries which go forward to the thyroid gland, tongue, and face.

### 1. ARTERIA THYROIDEA.

THE THYROID ARTERY, often also named the upper laryngeal artery, comes off from the external carotid almost in the very moment in which it separates from the internal carotid, and sometimes (the thyroid being always a very large artery) the carotid seems to divide into three branches, viz. the INTERNAL CAROTID, the EXTERNAL CAROTID, and THYROID arteries.

The THYROID, then, goes off the first branch; its place is behind the angle of the jaw; it goes downwards and forwards in a very tortuous form, till it arrives at the thyroid gland, upon which it is almost entirely expended; but yet it gives some branches, or rather twigs, of which the following are the chief:

1. One superficial branch goes upwards to the os hyoides, and sends its twigs sometimes under, sometimes over, the os hyoides: it belongs chiefly to that muscle and to that piece of membrane which join the os hyoides with the thyroid cartilage, named musculus hyo-thyroideus. This branch is both long and beautiful; it meets its fellow of the opposite side with free inosculations; it supplies cutaneous twigs, and twigs to the platisma myoides.

2. A second superficial twig goes downwards to the lower part of the thyroid cartilage, where it meets

the cricoid, and there gives little arteries to the mastoid muscle, jugular vein, and skin.

3. There is another branch which proceeds frequently enough from this second one: it belongs entirely to the larynx, for which reason the thyroid is often named the superior laryngeal artery: it dives immediately betwixt the cartilages of the larynx; it enters betwixt the thyroid and cricoid cartilages, carries in along with it a twig from the eighth pair of nerves; it gives its twigs to the epiglottis, and to all the small muscles which lie under cover of the thyroid cartilage, and which move the little arytenoid cartilages; and then passes outward emerging from the larynx, and appears again supplying the cryco-thyroideus muscle.

4. The fourth branch of the thyroid is properly the main artery, or continuation of this branch into the substance of the thyroid gland; it applies itself to the side of the gland, nourishes its substance by a great many small branches into which it is divided. These branches are all oblique, tending downwards and forwards. Their course is upon the side of the gland, because, indeed, the gland consists chiefly of two lateral lobes, and hardly any of the gland, or only a small portion crosses the trachea; consequently this artery does not inosculate so much with its fellow of the opposite side as with the lower thyroid, which comes from the axillary artery, and whose branches, mounting upon the lower part of the gland, have pretty nearly the same degree of obliquity with those of the upper thyroid.

## 2. ARTERIA LINGUALIS.

THE LINGUAL ARTERY is one of which the four branches are nearly of an equal size, and which of course require all of them to be equally well remembered. It is next to the thyroid, comes off immediately above it, goes forwards towards the os hyoides, and at the same time upwards towards the tongue; but all along it lies flat upon the side of the tongue upon its flesh or muscles, and gives the following branches.

1. Upon passing the horn of the os hyoides, it gives first one twig of less note backwards to the constrictor pharyngis, at the place where that constrictor arises from the horn of the os hyoides (viz. the constrictor medius;) and it gives another branch forwards round the basis of the os hyoides, where its meets its fellow: and to those who are acquainted with the muscles which arise from the os hyoides, it is needless to say what muscles it supplies *. This, which is named the RAMUS HYOIDEUS, seems to be very necessary, because it is a very constant branch; and when it does not come from the lingual, it infallibly arises from some other, commonly from the labial artery.

2. DORSALIS LINGUÆ is a branch which goes off from the lingual at the insertion of the stylo-glossus muscle into the tongue: it turns first outwards a little and then inwards over the root of the tongue, where the arteries of the opposite sides meet, and form a sort of net-work. Its chief branches are directed backwards towards the epiglottis and mouth of the pharynx amygdalæ, &c.

* Viz. the hyo-glossus, digastricus, mylo-hyoideus, the coraco-hyoidei, sterno-hyoidei, and hyo-thyroidei.

About

About the middle of the tongue, or about half way to the chin, measuring along the jaw, the lingual artery forks into two branches; the one below the tongue, the sublingualis, belongs to the sublingual gland and surrounding parts; the other remaining at the root of the tongue, belongs to the tongue itself.

3. SUBLINGUALIS then arises next; it comes from the side of the artery next the tongue; it runs under the sublingual gland, covered like it by the genio-hyoideus muscle, and emerges only when it arrives at the chin, where it terminates in the skin. Its branches are chiefly to the sublingual gland, which lies over it, and to the genio-hyoidei and mylo-hyoidei muscles and skin, for these are the parts which immediately cover it.

4. The ARTERIA RANINA is the larger branch of these two; it runs along the root of the tongue quite to the tip of it. In this course it is accompanied by its vein, which appears on the inside of the mouth when we turn up the tip of the tongue. This is the vein which the older physicians were so fond of having opened in sore throats; the artery is that which we are so apt to cut in dividing the frenulum linguæ; an awkwardness from which a great many children have died.

*N. B.* It runs along the genio-glossus, which is the innermost muscle of the tongue.

### 3. ARTERIA LABIALIS.

THE labial artery is named occasionally the EXTERNAL MAXILLARY artery, to distinguish it from one which

which goes off at a higher point, and goes to the inside of the jaw; or ANGULARIS, because it goes to the corner of the mouth and there divides; or FACIALIS, implying, that it supplies the face, as indeed it does as far as the angle of the eye and forehead, where there are other small arteries. Haller adheres to this name of LABIALIS, and in compliment to him we adhere to it.

This artery is still carefully kept down in the deep angle; although it is to come out upon the jaw, yet it is not exposed till it actually makes its turn: it lies under the stylo-hyoideus and the tendon of the digastric muscle: it is very tortuous, that it may move along with the jaw, and lies still so deep, even when it approaches the jaw-bone, that it is forced to make a very violent and sudden angle when turning over it. This sudden turn, which is sometimes almost a circle, is made, as it were, in the heart of the great submaxillary gland, the artery being buried under it. The labialis is a very large artery, very tortuous; sometimes one great trunk gives off two important arteries at once, the lingual and the facial; in which case they separate just at the angle of the jaw, where the artery, dividing the substance of the gland, is quite imbedded in fat. When we consider how deep this artery lies according to this general description, and the parts which it passes along, it becomes easy to foresee what branches it will give and to trace them in imagination.

1. Where it lies the deepest upon the side of the pharynx, it sends a branch directly upwards, which goes straight to the arch of the palate, spreading its small

twigs

twigs upon the arch of the palate, upon the velum palati and upon the uvula: it usually has two small branches for supplying these parts, one superficial and one deep; and thus the labial gives a particular artery to the palate, name ARTERIA PALATINA INFERIOR.

2. It gives a particular artery to the tonsil, which arises at the point where the stylo-glossus begins to mix with the other muscles of the tongue. This little artery penetrates the walls of the pharynx upon which it lies, and spreads its many twigs upon the tonsil and tongue.

3. While passing through the submaxillary gland, dividing it as it were, into two parts, the labial artery gives a great many small twigs into the substance of the gland itself; and after these it gives many twigs to the tongue, the skin, the muscles, &c. Of these, two chiefly are remarkable; one, which goes to the pterygoid muscle chiefly, though it also gives branches to the constrictors of the fauces and palate, and to the root of the tongue; and another artery, more constant and regular, which breaks off at the place where the labial artery curls and bends to turn upwards: it runs superficially, and goes straight forwards to the root of the chin, where it is named ARTERIA SUBMENTALIS: it turns upwards over the chin to the face at the middle of the chin, and often inosculates with some of the arteries of the face: it sometimes comes from the sublingual artery.

But the artery having emerged from betwixt the lobes of the submaxilly gland (for this artery in a manner divides it into lobes), and from among the fat with which it is surrounded, makes a sudden turn

over

over the angle of the jaw at that point where we feel it beating strongly; and then mounting upon the face, begins to give a new set of arteries.

1. A branch to the masseter muscle; for the labial artery passes over the jaw, and up the face, just at the fore edge of the masseter muscle; and this branch inosculates with a twig descending over the surface of the masseter from the temporal artery.

2. The labial artery ascending in the hollowest part of the cheek, and lying flat upon the buccinator muscle, gives out small branches to it, which inosculate chiefly with the transversalis faciei, another branch, and a very great one, coming from the temporal artery across the face. Here also the main artery has still a very serpentine line, on account of the continual motions of the part.

3. Before the artery comes to that point where it is to give off the coronary artery of the lower lip, it gives a branch named labialis inferior; which artery belongs to the lower part of the lower lip: its branches go to the triangularis and quadratus muscles, which lie on the chin and on the side of the chin, and also to the lower part of the orbicularis oris. This branch inosculates particularly with a twig, which comes from within the lower jaw through the mental hole, and with its fellow, and of course with the coronary arteries which run immediately above it, viz. in the red part of the lip.

The artery now divides into two branches, one for each lip, named the CORONARY ARTERIES, because they always surround the lips entirely, though their manner of going off is not perfectly regular. The

lower

lower coronary artery is usually smaller, and is to be named the branch, while the upper one not only surrounds the lip, but mounts along the side of the nose; it is larger; and is therefore to be considered as the continued trunk. We frequently observe the upper coronary larger on one side of the face, and the lower coronary larger on the other.

4. The LOWER CORONARY comes off about an inch or more from the angle of the mouth, at that point where the triangularis oris and many other muscles meet. It goes directly forwards to the angle of the mouth, enters into the lower part of the lip, and runs along the red pulpy part of it, where with the finger and thumb it can be felt beating. It inosculates with all the arteries formerly mentioned; as the submental, the twig which comes through the hole near the chin, the inferior labial artery, and with its fellow. With all these it inosculates so freely, that it signifies little from which side your injection is driven: it goes freely all round the lips, and the arteries are every where equally filled.

5. The UPPER CORONARY ARTERY we are to consider as the continued trunk. The labial artery is still rising, and still tortuous, when it arrives at the angle of the mouth; runs into the border or fleshy part of the upper lip, and runs along it till at the middle of the lip it meets its fellow of the opposite side, with a very free inosculation: yet the two arteries do not terminate here, but usually two very delicate arteries ascend towards the point of the nose, along that little ridge from the nose to the lip which we call the filtrum; and almost always two considerable arteries run

run up by the sides of the nose, one on each side; give off branches to the alæ nasi and to the cheeks; and growing gradually smaller, they arrive at last near the angle of the eye, and inosculate pretty freely with that artery, which is named ophthalmic, because it first nourishes the parts of the eye with many branches, and then comes out of the orbit at the corner of the eye, where, though small, it may be felt beating distinctly.

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## SECOND ORDER.

THE second set of arteries, which go backwards from the external carotid, comprehend the pharyngeal, the occipital, the auricular.

### 4. PHARYNGEA INFRERIO.

THE LOWER PHARYNGEAL * is a small slender artery; which gives no branches deserving to be numbered; it stands alone, and should be described as one simple artery, whose small branches spread all about the throat in the following manner.

This artery is smaller than any other branch of the carotid yet enumerated. It arises opposite to the lingual artery; and as it arises from the inner side, it

* It is named lower pharyngeal, to distinguish it from one which comes downwards from the internal maxillary. Vide p. 285.

comes

comes out in a manner from the fork betwixt the external and internal carotid arteries: it rises upwards very slender and delicate; it lies deep in the neck, upon the fore-part of the flat vertebræ, or rather lies upon the flat face of the longus colli muscle*. After rising in one slender artery, single, without branches or connections, it begins all at once to give twigs.

First, It gives branches inwards to the throat; for one twig surrounds the lower part of the pharynx about the root of the tongue, and sometimes goes forwards along with the glosso-pharyngeal nerve into the tongue. Another twig goes to the middle of the pharynx, and wanders towards the velum palati, giving branches to the amygdalæ. And still another goes higher towards the basis of the skull; it also gives twigs to the velum palati, to the back of the nostrils, to the upper part of the pharynx where the upper constrictor lies (viz. that which comes from the basis of the skull), and it gives small arteries to nourish the basis of the skull; as, to the os sphenoides, to the cuneiform process of the occiput, to the point of the temporal bone, and to the cartilage of the Eustachian tube.

Secondly, It sends branches outwards to the mastoid muscle, to the jugular vein, to the ganglion of the intercostal nerve, and to the dura mater of the eighth pair; and one particular branch, very small

* When dissected, it must be taken out in a manner from behind the œsophagus. The carotids must be raised outwards before it can be seen; for it lies under them, betwixt them and the throat.

and

and delicate, goes along conducted by the great jugular vein, enters together with it into the skull, and makes one of the arteries of the dura mater, but it is a very delicate twig. In general one artery only of the dura mater is known or mentioned; but here we have seen, besides the great artery of the dura mater, lesser arteries entering to it by all the perforations at the basis of the skull. The pharyngeal actually terminates in the dura mater, passing through the foramen lacerum anterius, and sending also a branch in together with the jugular vein. The occipital artery also sends one with the jugular vein, one by the foramen mastoideum, and one by a small hole in the occiput. The temporal often sends one through by the hole in the back part of the parietal bone.

### 5. ARTERIA OCCIPITALIS.

THE OCCIPITAL ARTERY is also a simple artery, distributing its twigs about the ear, over the occiput, and down the back of the neck, and having no branches of sufficient importance to be particularly marked.

It arises next to the pharyngeal from the back part of the carotid; and lying particularly deep, it not only is covered at its root by the other branches of the carotid, but is covered in all its course by the thick muscles of the neck, except just where it is passing round the mastoid process.

At first the occipital artery lies close in among the bones, passing over the transverse process of the atlas, crossing the root of the great jugular vein, and passing

 under

under the root of the mastoid process, so as to lie at this place under the belly of the digastric muscle. Still as it encircles the occiput, it passes along very deep under the bellies, first of the trachelo-mastoideus, and then of the splenius and complexus, and emerges only when it arrives at or near the middle ridge of the occiput; and lastly, it rises with many beautiful branches over the back of the head, to meet the branches of the temporal artery.

In this course the occipital artery sends out the following branches:

1. Branches to the biventer which lies over it, and to the stylo-hyoideus muscle; and there is one longer artery which attaches itself to the root of the mastoid muscle, and passes along that muscle, to inosculate with the thyroid arteries, or with the lower cervical arteries, which mount upwards as this descends.

2. Next it gives, like the pharyngeal, a small artery, which goes backwards along the jugular vein; and having entered by the foramen lacerum, attaches itself within the skull to that part of the dura mater which lies under the lobes of the cerebellum.

3. The occipital artery, as it passes under the ear, sends out to it a small posterior artery, which goes to the little lobe of the ear, and creeps up along its posterior border.

4. At this point the occipital often gives another artery, which passes upwards behind the ear, and is named the POSTERIOR TEMPORAL ARTERY.

5 The

5. The occipital artery, as it passes under the trachelo-mastoideus and splenius, gives branches to these two muscles; and it sends out from betwixt the trachelo-mastoideus and complexus a long branch, which descends along the neck a considerable way; and after having further supplied the splenius, complexus, and also the deeper muscles of the neck, it terminates by inosculating with a branch from the axillary artery, which as it crosses the neck is named transversalis colli. This descending branch of the occipital inosculates also with the vertebral arteries through the interstices of the vertebræ.

Having pierced the belly of the complexus, the artery now rises over the occiput in small and beautiful arteries; the chief of which belong to the occipital belly of the occipito-frontalis muscle and to the skin: it finally ends in inosculations with the back branches of the temporal artery. But of these extreme twigs of the occipital, two are remarkable, because they pass through the skull to the dura mater; one through a small hole in the occipital spine, and one through that small hole which is behind the mastoid process. Sometimes the hole is in the temporal bone, but more frequently in the suture which surrounds the back part of the temporal bone*.

### 6. ARTERIA POSTERIOR AURIS.

The posterior artery of the ear is the smallest and least constant of all the arteries which go off from

* Viz. the additamentum suturæ squamosæ.

the carotid; for it is often wanting, or often comes from some branch, and not from the carotid itself; often from the occipital, sometimes from the pharyngeal artery; it can scarcely be reckoned as a regular branch of the carotid. This artery also, like the pharyngeal and occipital, gives out no distinguished branches which we need to mark; it chiefly belongs to the ear, it gives branches to the cartilage of the external ear, it sends a larger branch through the stylo-mastoid hole to the internal ear, and the rest of its twigs go to the integuments, or to the bones.

The posterior auris arises much higher than any of those arteries which have been just described; it does not come off from the external carotid till it reaches the parotid gland; or, rather, it arises where the carotid is plunged into the substance of that gland; it passes directly across under the styloid process, and over the belly of the digastric muscle, and then goes up behind the ear; in this passage it gives branches to the parotid gland, and to the biventer muscle, the parts on which it lies; next it gives a twig, which furnishes the root of the cartilage of the ear, and perforates the lowest part of the cartilage, so as to spread itself upon the drum of the ear; and this branch, named arteria tympani, is particularly large in the child, which has a peculiar conformation, a preternatural membrane covering the drum of the ear.

Its next branch, the arteria stylo-mastoidia, is the most remarkable, for it is of considerable size, enters the mastoid hole, while the corda-tympani, or great nerve of the face, comes out: it is a chief artery of the internal ear; for it gives branches, 1. to the tym-

tympanum, one of which beautifully surrounds the bony circle, and then spreads upon the membrane itself; 2. to the muscle of the stapes, to the semicircular canals, to the cells of the mastoid process and its delicate vessels; which arteries, when well injected with size, paint the walls of the cavity of the tympanum, and of the semicircular canals.

The main artery having given off the arteria tympani and this stylo-mastoid artery, and having passed the stylo-mastoid hole, becomes properly the arteria posterior auris, rising behind the ear, and giving its branches to the skin and mastoid muscle, and to the muscle behind the ear (posterior auris), and to the bone and periosteum, chiefly about the mastoid process; then its small branches play round the back part of the concha or shell of the ear; and, lastly, the artery, still mounting behind the ear, ends in small twigs, which go to the fascia of the temporal muscle, and which of course inosculate above the ear with the temporal artery.

## THIRD ORDER.

The third order of arteries includes the termination of the external carotid artery in the temporal and maxillary arteries, which is after the following manner:

The artery having entered into the parotid gland, lies there absolutely imbedded in its substance; and of the two arteries in which it terminates, one passes directly through the substance of the parotid gland,

emerges before the ear, mounts upon the temple, and is named of course the TEMPORAL ARTERY; it performs here in the temple the same office which the occipital does behind, viz. it supplies the pericranium, muscles, and skin: all this is very simple. But the other branch, in which (since it is exceedingly large) one would say the carotid terminates, goes off from the temporal with a sudden bend, sinks very deep under the articulation of the lower jaw, terminates in a lash of branches at the back of the antrum Highmorianum, and there gives branches to the lower jaw, the upper jaw, the inside of the cheeks, to the temple (deep arteries which lie under the temporal muscle), to the upper part of the pharynx, to the nostrils, and to various other parts; it is this artery too which gives off the chief artery of the dura mater. The description of so great an artery, so widely distributed, becomes both difficult and important.

### 7. ARTERIA MAXILLARIS INTERNA.

THE INTERNAL MAXILLARY ARTERY turns off from the temporal artery while imbedded in the substance of the parotid gland, and about the middle of the upright branch or process off the lower jaw-bone. It passes betwixt the lower jaw-bone and the outer pterygoid muscle; it then goes forwards till it touches the back part of the antrum maxillare, and terminates in a lash of vessels betwixt the back of the antrum and the pterygoid process; and, finally, it ends at the spheno-maxillary fissure, or, in other terms, at the bottom of the socket of the eye, where it gives the infra-

infra-orbitary artery, and a branch to the back of the nostrils.

In all this course the internal maxillary artery is extremely tortuous: First, It rises with a high and round turn at that point where it goes off from the temporal artery; then it bends suddenly downwards, where it passes betwixt the pterygoid muscle and the jaw-bone; then, as it approaches the back of the antrum, it rises with a third bending, and continues rising with very great contortions, till it ends in a lash of small vessels at the back of the eye and nostrils.

Before this artery gives out its greater branches, which require to be marked with numbers, it very generally gives some small twigs, nameless, and of less note; as a small twig to the ear, and the glands around it, another which gets into the tympanum to the muscle of the maleus, and a branch of it sometimes goes into the skull by that hole named foramen ovale, by which the fifth pair of nerves come out, and goes to that part of the dura mater which covers the sides of the sella turcica.

1. Of the larger branches which the internal maxillary gives out, the first is the ARTERIA MENINGEA, the great or MIDDLE ARTERY of the DURA MATER. It goes off from the maxillary just where it leaves the temporal artery. Sometimes before entering the skull it gives small branches to the pterygoid muscle, to the mouth of the Eustachian tube, to the os sphenoides, and sometimes through that bone to the dura mater; but the main artery passes through what

is called the spinous hole, which is in the very extreme point or spine of the sphenoid bone: it is this artery of which the surgeon should be particularly aware, and which touches the parietal bone at its lowest corner in the temple, and spreads from that point all over the dura mater like the branches of a tree. But besides these, its chief branches, which spread thus upon the parietal bone, on its inner surface, it gives smaller ones, which go into the substance of the bone, or into the ear, and sometimes through the orbit into the eye. Thus first several smaller twigs go into the substance of the os petrosum to nourish it; the holes may be seen about the rough part, where the os squamosum and os petrosum are united; next two twigs enter into the aqueduct by the small hole on the fore part of the petrous bone, one keeping to the canal itself, the other going to the cavity of the tympanum, and to the inner muscle of the maleus; and, lastly, one or two small twigs pass through the outer end of the foramen lacerum into the orbit, and go to the lachrymal gland*.

2. The LOWER MAXILLAR ARTERY is a slender and curious artery, which belongs chiefly to the teeth of the lower jaw, and which runs all along in a canal within the jaw-bone. The internal maxillary proceeds nearly an inch before it gives off this branch; and then, while lying under the pterygoid muscle, it gives it off a long and slender artery, which enters the jaw-

* Sometimes the great and proper artery of the lachrymal gland, instead of arising from the opthalmic or proper artery of the eye, arises thus from the artery of the dura mater.

bone

bone at that great hole which is betwixt the condyloid and coronary processes; then runs all along within the jaw-bone, surrounding each of the teeth with arteries at the bottom of each socket. About the middle of the jaw-bone it divides into two branches, which proceed together in the bony canal, till one of them emerges upon the chin at the mental hole, inosculating there with the arteries of the face, viz. the labial and submental arteries, while the other goes onwards to supply the roots of the fore teeth also, and to meet its fellow within the jaw-bone at the chin. The nerve for the lower jaw enters along with this artery; the vein of this artery accompanies it, but lies under it in a separate canal, though still in the same line. The artery itself, before it enters into the hole of the lower jaw, commonly gives twigs to the inner pterygoid muscle which covers the hole. Considering the size of this artery, we cannot wonder at profuse bleedings from the teeth, or rather from their sockets.

3. THE PTERYGOID ARTERIES.—While the artery is thus crossing betwixt the jaw and the pterygoid muscle, it gives branches to the external pterygoid muscle, both into its substance and over its surfaces. The number of these pterygoid arteries is variable and unimportant.

Next, while the maxillary artery is passing in a contorted form under the zygoma, where the temporal muscle is lodged, it gives off two arteries, which are called the DEEP TEMPORAL ARTERIES, to distinguish them from the proper temporal artery, the only one which we feel outwardly, and which is superficial. Of these two deep temporal arteries, one runs

more

more outwards, viz. towards the ear, the other runs more inwards, viz. closer upon the bone; whence the one is called the DEEP EXTERNAL, the other the DEEP INTERNAL, TEMPORAL ARTERY.

4. The DEEP EXTERNAL TEMPORAL ARTERY arises where the maxillary is passing under or near the jugum; it is of course near the coronary process of the jaw-bone. This branch then passes along the tendon of the temporal muscle, and ends in that muscle, giving branches also to the external pterygoid muscle; it is a short artery, and not very important by its size.

5. The deep internal temporal artery arises farther forwards, viz. where the artery is close upon the back of the antrum; from which point, mounting directly upwards, it passes in the very deepest part of the temporal arch, viz. that which is formed by the cheek-bone. It is longer and more important than the outward branch, supplies the deepest and thickest part of the temporal muscle, mounts pretty high upon the temple betwixt the muscle and the bone, and often, where it lies behind the cheek-bone, it sends a branch through that bone into the orbit which supplies the fat and periosteum of the socket, and in some degree also the lachrymal gland.

6. The ARTERY OF THE CHEEK is a very regular artery, in so far as regards its destination, viz. for the cheek; but in its origin it is extremely irregular. It has not often the importance of coming off as a distinct branch from the maxillary; but comes off rather more frequently from some of its branches, as from the deep temporal artery just described, or from the

alveolar

alveolar or infra-orbital arteries, which are presently to be described. This artery perforates the buccinator muscle, and is spent upon it, and upon the other muscles of the cheek, as the zygomaticus and levator labii; it ends, of course, by inosculations with the arteries of the face.

7. The ARTERY OF THE UPPER JAW serves much the same office with that of the lower jaw, viz. supplying chiefly the sockets of the teeth; whence it is named ARTERIA ALVEOLARIS. It is an artery fully as large as that of the lower jaw; it begins upon the back of the antrum Highmorianum, and runs round that tuberosity towards the face and cheek with very tortuous branches. Its branches are distributed first to the buccinator and fat, which fills up the great hollow under the cheek-bone, and also to the cheek-bone itself, where it is connected with the jaw-bone. Secondly, Other branches perforate into the antrum Highmorianum by small holes, which are easily seen upon its back part or tuber, and some of these branches go into the sockets of the backmost teeth. Thirdly, A more important branch than any of these, the branch indeed from which it has its name of alveolar artery, enters by a hole into the substance of the jaw-bone, and goes round in the canal of the teeth just as the artery of the lower jaw does, giving branches to each socket. The curlings of this artery upon the back of the antrum are very curious; and while its deeper artery furnishes the teeth, some of the superficial branches go to the gums.

8. The INFRA-ORBITAL is so named from the hole or groove by which it passes all along under the eye, from

from the back of the nostril till it emerges upon the face. The infra-orbital, and the branch last described, viz. the alveolar artery, generally come off from the maxillary by one common trunk; the alveolar goes forwards and downwards by the back of the antrum; the infra-orbital mounts upwards, and enters the spheno-maxillary hole, or rather it comes off just at the spheno-maxillary hole, which is the great slit at the bottom of the eye. As the artery enters its proper canal at the bottom of the eye, it gives some twigs to the periosteum and to the fat of the socket; as it passes along its canal in the bone, one branch dives down into the antrum through the bone; for this plate of bone in which its groove runs, is at once the floor of the eye and the roof of the antrum; within the socket it gives twigs also to the deprimens occuli, and to the lower oblique muscle, to the lachrymal sac, or even to the nostrils; when it emerges from the socket by the infra-orbitary hole, it terminates in the levator labii and levator anguli oris, and in inosculations with the arteria buccalis, labialis, and especially with the nasal branch of the occular artery. This infra-orbitary artery is accompanied through the canal, and out upon the face, with a small nerve of the same name, viz. the infra-orbitary nerve.

After this the maxillary, though nearly exhausted, still sends out three small arteries, in which it terminates irregularly, sometimes one, sometimes another twig being larger. Of these three, one goes to the palate, one to the pharynx, one to the nostrils.

9. The UPPER PALATINE ARTERY arises near the infra-orbital; and from that point, viz. the spheno-

maxillary

maxillary slit, it descends along the groove, which is formed betwixt the pterygoid process and the palate bone; and when it has got down to the palate, one lesser branch turns backwards through the posterior palatine hole, and expands upon the velum palati; the other larger branch is the great palatine artery, for it comes through the anterior or larger palatine hole; the artery itself is large, it runs all along the roof of the mouth betwixt the pulpy substance of the palate and the bone; in this progress it gives little arteries to the sockets of the teeth, and it frequently terminates, not merely in the palate itself, but in a small artery which runs up through the foramen incisivum, or hole under the fore teeth, into the cavity of the nose. This artery is also accompanied with a corresponding palatine nerve.

10. The UPPER PHARYNGEAL ARTERY is the highest of all the branches of the internal maxillary; it goes off at the back of the orbit, opposite the spheno-maxillary fissure; it ascends along the sphenoid bone to the place of the sphenoidal sinus, and along the upper part or arch of the pharynx, where that bag adheres to the basis of the skull; it also goes along the sides of the pharynx; its twigs are of very diminutive size; some go into the substance of the sphenoid bone to nourish it by small holes both over the cells and in the alæ: a branch goes towards the pterygoidean or vidian hole*, where it inosculates usually with a branch from the internal carotid artery, some-

* This is the hole by which the recurrent of the 5th pair goes backwards from the nose into the skull.

times

times with the lower pharyngeal, or with the meningeal arteries.

This artery ends in small branches which play round the mouth of the Eustachian tube.

11. The NASAL ARTERY is the last branch of the internal maxillary. It passes through the spheno-palatine hole*; by this opening it comes into the nostril at its upper and back part; the twigs go, one shorter to the backmost of the æthmoid cells, another to the cells of the sphenoid bone; one longer branch goes to the back part of the septum narium; and one branch, the longest of all, often passes both the upper and lower spongy bones (along the lining membrane of the nose, giving twigs to the antrum as it passes), till it inosculates with that twig of the palatine artery which rises through the foramen incisivum into the nose. This nasal artery often has two branches.

## 8. ARTERIA TEMPORALIS.

The TEMPORAL ARTERY, if we consider its straight direction, may be regarded as the termination of the internal maxillary artery. When the maxillary artery bends away from it to go under the jaw, this goes

* Observe, this is not the spheno maxillary slit so often mentioned; which is a slit-like opening lying between the wing of the sphenoid bone and the upper jaw-bone; for it is at the bottom of the socket; and whatever parts enter it go to the eye. The spheno-palatine hole is betwixt the sphenoid and palate bones; it is at the back of the nostrils, and the branch which enters it belongs to the nostril.

directly

directly forwards through the substance of the parotid gland, mounts before the ear; and as it passes alternately the parotid gland, the face, the ear, it gives its three chief branches to these parts, and ends in that temporal artery which runs along the side of the head under the skin, which we feel, and even see distinctly, beating, and which we open when bleeding in the temples is required.

The temporal artery is named SUPERFICIAL because of its lying under the skin only, above the fascia of the temporal muscle, while the deep branches from the maxillary artery lie under the muscle.—The temporal artery passes just before the meatus auditorius, and behind the branch of the jaw-bone; it pushes its way through the substance of the parotid gland, and there it gives its first branches, commonly seven or eight in number, but quite irregular, into the substance of the gland itself; next it gives off to the face an artery of very considerable size; which arises from the same part of the artery with these parotideal branches, viz. under the zygoma and within the gland: like them it goes off almost at a right angle, and is like one of them, but larger, nearly of the size of a crowquill; it pushes sidewise through the substance of the parotid, emerges from it upon the face just below the cheek-bone; runs across the cheek in the same direction with the parotid duct; it is named from this direction TRANSVERSALIS FACIEI. Its branches go to the joint of the jaw-bone, the masseter, buccinator, parotid gland, &c. and terminate in inosculations with all the arteries of the face.

Next

Next the temporal artery, as it rises towards the zygoma, and of course approaches the angle of the jaw, gives an artery which is proper to the articulation of the jaw. This artery belonging to the joint of the jaw is often named ARTERIA ARTICULARIS. After having sent its two branches to the articulation of the jaw, it sends another artery to the ear, which divides into two twigs; one of them going round the back part of the ear, assists the branch of the stylo-mastoid artery in forming the little circular artery of the tympanum; while another branch, penetrating through the slit which is in the articulation of the lower jaw, goes to the muscle of the malleus.

But before it reaches the zygoma, the temporal artery gives another branch, which is named the MIDDLE TEMPORAL ARTERY, to distinguish it from the deep temporal arteries which lie under the whole thickness of the temporal muscles, and the superficial temporal, which lies above the fascia; for this middle temporal artery lies under the fascia: but on the outside of the muscle it arises from the main artery just under the zygoma, rises over the zygoma, and then pierces its way under the fascia of the temporal muscle, and under that covering gives branches to the temporal muscle, the artery itself still rising and passing obliquely forwards towards the outer corner of the eye, where one of its twigs often goes to the orbicularis oculi, and inosculates with the ophthalmic artery.

About this point, or rather above the zygoma, the temporal gives off those small arteries, irregular in number, which are named ANTERIORES AURIS, the anterior

anterior arteries of the ear, and which play all round the fore part of the ear.

The temporal artery having now emerged from the parotid gland, and from the thick fascia which covers it, makes a sudden serpentine turn before the ear; and then rising about half an inch perpendicularly, it forks with a pretty wide angle into two arteries, which are named the anterior and posterior temporal arteries. These lie quite superficial under the skin, above the fascia, and are distributed in this manner: First the ANTERIOR TEMPORAL ARTERY goes directly forwards to the naked part of the temple, runs up the side of the forehead with a very serpentine course; it is here that in old men we see its contortions and pulsation very distinctly; it goes round arching forwards and upwards from the temple towards the top of the head. It belongs chiefly to the skin and frontal muscle, and that tendinous kind of sheath which covers the cranium; it gives some branches to the orbicular and corrugator muscles; it forms often a superciliary arch with the proper frontal artery; it often sends off a branch very early towards the outer corner of the eye, which is entirely destined for the orbicularis oculi.

The POSTERIOR TEMPORAL ARTERY is the last branch of all. It arches backwards over the top of the ear; it turn thus backwards till it meets the branches of the occipital artery; it deals its branches from either side upwards and downwards, i. e. towards the ear, and towards the top of the head in great profusion, till it is quite exhausted. These branches belong to the skin chiefly and to the pericranium;

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and the smaller twigs pierce the outer tables of the skull, and go into the bone in great profusion for its nourishment.

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## CONCLUSION.

It would surely be wrong to conclude the description of a system of arteries so important as this, without attempting to interest my reader in this piece of anatomy, by observing a few anatomical and surgical facts.

That arteries are not tortuous to favour the extension of parts, but rather because they have been extended and long pushed by the current of blood, is a fact very manifest to any one who considers the condition of many of these arteries which I have just described. When we first observe the thyroid, lingual, and labial arteries; when we consider that the tongue, the throat, the lips, are moveable and dilatable parts—we are apt to say that such arteries are tortuous to favour those motions. But when we remark the curling form of the alveolar artery, where it lies against the back of the antrum; of the occipital artery, where it lies firm against the bone; of the temporal, where it rises along the side of the head—we perceive clearly that this curling has nothing to do with dilatation. And Dr. Hunter's observation of the arteries of the womb being tortuous, to allow of extension, is not like the observation of so great an anatomist, but of one who had not considered many of the chief arteries

in

in the body: For the womb itself has its arteries more tortuous at the end of pregnancy than at its commencement; and the stomach, the bowels, the bladder, although they suffer greater and more sudden distention than the womb, have arteries which are very straight in their course. Are there any curling arteries in the muscles which contract to one half their diameter? are there any in the joints which twist and bend so freely? are there any curling arteries in the whole system of a child? are there any arteries in the whole system of an aged person which want this tortuous form? In short, this tortuous form has no relation to the dilatation of the parts: it is merely a consequence of the long continued pressure of the blood: it is this only that can account for the slowly increasing tortuosity in the temples or hands of an old man, or the sudden tortuosity which the newly dilated artery assumes after the operation for aneurism.

Next it is natural to observe, as a thing which may prevent confusion in the student's mind, how irregular (after all our attempts at arrangement) the smaller arteries unavoidably must be; how natural it is that each particular part should draw its blood from all the arteries which are near or round it. The ear has its posterior artery peculiar to itself; but it has also an anterior artery from the temporal, where it lies under the parotid gland; and it has even a superior auris from that branch of the temporal artery, which bends round towards the occiput, and arches over the ear. The dura mater has its great middle artery appropriated to itself, a peculiar branch, the first of the

maxillary artery; but it has besides small assisting arteries, entering by almost every point at the basis of the skull; and especially it has arteries from the maxillary, by the mouth of the Eustachian tube, from the pharyngeal, running in by the hole for the great jugular vein; and from the occipital both by the hole of the jugular vein in the basis of the skull, and also by the small occipital hole in the back part of the skull, close by the temporal bone. The throat also, though it has many peculiar arteries, derives its branches from a great many sources; as from the lingual artery by twigs, which cross the root of the tongue; from the labial artery by branches, which go to the tonsil, tongue, and palate; from the pharyngeal artery, many branches not confining themselves to the pharynx, stretch forwards to the palate, tongue and tonsils; and lastly, the maxillary artery gives a profusion of branches to all parts of the throat. These may serve as hints by which the student, if he wishes to become a correct anatomist, may trace the inosculations; or for the surgeon, if he wishes to separate the study of this minute anatomy from that of the greater arteries.

The surgeon's interest in understanding these arteries is, indeed, very strong. It were impossible to enumerate all the various occasions on which this piece of anatomy may be useful; but, surely, one may easily say enough on this subject to attach the young surgeon to the diligent study of these arteries.

Among the various motives for diligence, I would mention these; the terrible hamorrhagies which he is daily called to stop, when suicides, though they have

not

not cut the carotids, have cut the great arteries of the thyroid gland; the necessity of thinking about the tumours of the gland itself, for I have had the unhappiness to see a person perish by suffocation while consulting physicians forbade any operation; and I had no other than the melancholy privilege of watching, for many hours, the last struggles of a person, who had the day before been walking through all the rooms in tolerable ease and health. Could nothing have been resolved on? Must we always submit to this? Might not an incision in the fore part (where few arteries are) have at least uncovered the trachea, given a temporary relief, and made the tumour suppurate more freely? The extirpation of the tongue, which is mentioned with horror, would be a less terrible operation to one acquainted with these arteries; the extirpation of all tumours under the jaws is dangerous; the cutting out completely the parotid gland is a thing quite impossible, since the greatest of all the arteries, viz. the temporal and the maxillary, lie absolutely imbedded in the gland. What shall we think, then, of those surgeons who talk in such familiar terms of cutting out the parotid gland? Bleedings from the nose have been so often fatal, that Petit is celebrated to this day for a discovery which he never made, viz. the way of plugging the nose so as to stop this bleeding. Have not the French Society been busy renewing inventions for securing even so small an artery as that of the dura mater? In the hair-lip operation, in cutting cancers, in dissecting tumours from all parts of the face, the surgeon commands the blood only by knowing these arteries. Cowper the

 celebrated

celebrated surgeon and anatomist, had his head so full of this project, that instead of waiting for hæmorrhage during his operation, he cut off two days before the chief source of the blood. He was going to cut out the parotid gland; and two days before he placed a small button of caustic on each side of the labial artery where it lies upon the cheek, passed a ligature under it, tied it firm, and then proceeded to his operation next day. But this great anatomist made at one stroke two grievous blunders: he missed, for want of knowledge, the chief arteries of the parotid gland, for they come from the temporal artery; and, if I mistake not, he had tied the vein, for most assuredly it is the fascial vein which he is describing in his twelfth table from Bidloo. How terrible the extirpation of tumours from the gums, throat, tonsils, &c. I need not, say; where the surgeon always uses burning irons instead of needles, where not unfrequently the patient dies.

SECT.

## SECT. II.

# OF THE ARTERIES OF THE BRAIN, SPINAL MARROW, AND EYE.

### § 1. OF THE ARTERIES OF THE BRAIN.

The internal carotid arteries are named the arteriæ cerebri, as being the chief arteries of the brain; while, in truth, the brain is also supplied by two other arteries nearly equal in size, viz. the vertebral arteries, which, though they do indeed arise from a different trunk, viz. the axillary artery, yet are so entirely destined for the brain, give so few branches before they reach the skull, are so important when they arrive there, and above all make so large a communication with the carotid arteries, that without a description of the vertebral arteries, any description of the carotids must be defective; they unite so with the carotids as to form but one great system of vessels for supplying the brain.

The two greatest functions of the animal body, those of the womb and of the brain, the one for the life of the individual, the other for the continuation

of the species, are the most liberally supplied with blood. The womb has on each side two arteries; it has two spermatics, and two hypogastrics, and the inosculations of these vessels are very large and free. The brain has two great arteries on each side; it has two carotids, and two vertebral arteries; they are infinitely larger than those of the womb; their inosculations are so particular, that there are no others like them in all the body: the injection of any one artery easily fills the whole; the preservation of but one artery saves the life of the creature, when the others are stopped.

These four arteries alone convey to the head the fifth part of the whole mass of blood. This is the calculation of the older authors; and even those who would settle it at the lowest point still acknowledge, that the carotid and vertebral arteries receive at least the tenth part of all the blood of the body. The brain then, which weighs not a fortieth part of the whole body, receives one tenth of all the blood; a proportion which must occasion surprise.

Besides the profusion of blood which thus rushes into the brain, the impetus with which it forces its way seems dangerous; and Nature also seems to have provided against the danger. We cannot be but sensible of this danger; for the slightest increase of velocity occasions strange feelings, if not absolute pain. We cannot run for any length of way, nor ascend a stair rapidly, nor suffer a paroxysm of fever, nor in short have the circulation quickened by violent exertions, by emotions of the mind, or by disease, without feeling an alarming beating within the head; we feel it particularly

particularly in the carotid canal where the artery passes through the bone. If it continue from disease, or if we persist in our exertions, giddiness, blindness, ringing of the ears, come on. Haller remembers, that while he was laying in a bad fever, he suffered so much from the pulsations of the carotid artery within the skull, that his head was lifted from his pillow at every stroke. I wish he had said, " seemed to be lifted from his pillow at every stroke ;" for it was rather a sickly feeling than what could actually happen.

Did this vast column of blood rush directly into the brain, we do not know what might be its effects ; but surely they could not be harmless, since Nature has provided against it in Man, and in the lower animals which hang their heads, with a peculiar care. In Man, this blood is retarded chiefly by the tortuous course which the artery is obliged to follow, and by that long bony canal which, by holding the carotid as in a sheath, must suppress its violent action, and at least prevent its being dilated by force of the blood, when, as often happens, the lower part of the artery is more full and tense. Perhaps also it may have some effect, that the carotid, as it lies by the side of the sella turcica, is not naked and free, but is inclosed in a venous sinus, which consists of cells like those of the male penis, and in the heart of which the carotid lies bathed in the blood.

It is also peculiar in all the arteries of the brain, that they do not enter in trunks into its substance. This seems to be a violence which the soft texture of the brain could not bear ; but all the arteries having perforated the

the dura mater, attach themselves to the pia mater, a delicate membrane, which is the immediate covering of the brain; which follows all its divisions, lobes, and convolutions; which enters all its cavities, and lines its internal surfaces as it covers the external. To this membrane of the brain the arteries attach themselves: it conducts them everywhere along the surface of the brain, and into its cavities; and when the arteries are to enter into the substance of the brain, they have already branched so minutely upon the pia mater, that they enter into the pulpy substance in the most delicate twigs; so that having injected the brain, at whatever level you cut into it, you find its white surface dotted with red points regularly, and like the dots of a pin.

But in the lower animals, especially in the Calf, the Deer, the Sheep, which hang their heads in feeding, there is a provision of so singular a nature, that we can have no doubt that these contortions of the great trunks and minute divisions of the smaller arteries in Man have the same final cause; for in those creatures the carotid, before it enters the brain, first divides into innumerable smaller arteries. Not one of these is sent off for any particular function: they are immediately reunited again, and gathered together into one trunk; and then the force of the blood being thus broken, the artery divides a second time into branches of the ordinary form, which enter safely into the substance of the brain.

It is still further supposed, that the arteries of the brain have this peculiarity, distinct from all others in the body, that as they enter the skull they lay aside one

one of their coats, and that of course the arteries of the brain are peculiarly weak. That the arteries of the brain want that outward coat of cellular substance which all arteries passing through other cavities or along the limbs have, is no doubt true, and so far they are thinner: but how much they are weakened by this loss, it is not easy to say; for they want none of the coats which are essential to the constitution of an artery; and this cellular coat, though it constitutes much of the thickness of an artery, has, I believe, but little to do with its strength. Yet true it is, that the arteries of the brain, either from being weaker in themselves, being less supported, lying upon the soft and pulpy substance of the brain, are more frequently burst by falls, or even by the slightest accidents, than the arteries of any other part, even the limbs, however much exposed. Our injections burst them very often; the slightest blow or fall upon the head often produces an internal effusion of blood, which occasions death; but that the arteries of the brain are so delicate as to be burst by a false step, so as to produce a fatal aneurism within the brain, is a truth perhaps not commonly known.

A young woman, carrying in her arms her first child, about six months old, slipped her foot with a slight shock; but it was on plain and even ground, and she did not fall down. In the instant of this shock she was sensible of a sudden pain in the right side of her head: it was so peculiar, that she said she could cover the point with her finger; and though slighter at intervals, this pain never left her to the moment of her death. She walked home, went about

her

her little family-matters, suckled her child; but was seized that evening with sickness, not violent like that of any sudden disease, but rather like the easy vomiting of a pregnant woman.

She continued very sick, with slight headach; but still was out of bed all day long, went about her household affairs, and had no symptom which could lead one to suspect her very dangerous condition, or what a dreadful accident had happened. She got up during the night after this accident for some cool drink, felt herself extremely giddy, was obliged to support herself by a chest of drawers which stood by her bedside, and went to bed again immediately. On the evening of the second day she got out of bed, made tea as usual, was out of bed during the evening, had no complaint, except the continual sickness, slight pain of the head, and giddiness still slighter. That night she expired. Her pulse all along had beat low and weak, and never more than 60 in the minute.

When I was brought to open the body, I heard nothing of the pain of her head, though it was fixed and constant, and without that nothing could be more puzzling than this combination of circumstances. First, the sudden slipping of her foot, and the incessant sickness which ensued, suggested the idea of hernia; but no such secret was known among her relations; and upon opening the abdomen, no hernia was found, neither open nor concealed, as in the thyroid hole.

Next we were informed of a palpitation, which had been usual with her. It appeared that she had complained chiefly about the period of her first menstruation, and some years before her marriage. It seemed

to

to be hysterical merely; but upon opening the thorax, we found the heart wonderfully enlarged and crammed with a dark and grumous blood.

But next a new scene opened upon us; and this enlargement of the heart appeared to arise like that of the liver, which so often accompanies fractured skull, from the languid action of the heart and torpor of all the system in those who lie even for a few days comatose.

Now, for the first time, I was informed that the shock of slipping her foot had caused a sudden pain of the head; that it was pointed, confined to one single spot, incessant, accompanied with perpetual vomiting or desire to vomit, and with giddiness during the night.

Upon opening the head, I found the dura mater of a most singular appearance; livid, or rather like the gizzard of a fowl, with green and changing colours. Having cut it open the pia mater appeared like red currant jelly, with fresh coagulated blood so firmly attached to it, that it seemed as if driven into its very substance and incorporated with it. Upon cutting and tearing open the pia mater, each convolution of the brain was surrounded and separated from that next it by coagulated blood. Upon cutting into the ventricles of the brain, that of the right side was found to contain four ounces of entire and coagulated blood; the cavity at first view was like opening a ventricle of the heart; the blood, very dark and firmly coagulated, was forced out by the pressure of the surrounding parts; the coagulum became gradually firmer and whiter, till it turned to a very firm stringy clot, which

stuck

stuck in the mouth of the middle artery of the brain. Being carefully examined, it was found to be sticking firm in the mouth of the artery which had burst, as if by the separation of two of its rings. The blood, which thus filled the right ventricle, had also made its way down in prodigious quantity into the third and fourth ventricles, quite into the occipital hole; but the opposite ventricle of the same side it had not filled.

The quantity of blood ascending to the head is exceedingly great; its free circulation in all the arteries is perfectly secured; and the plan of its distribution is extremely simple, for the carotid entering by the os petrosum gives three branches. First, A branch which unites the two carotids with the two vertebrals, and forms the fore part of the circle of Willis. Secondly, It gives an artery to the great middle lobe, whence it is named the great middle artery of the brain. Thirdly, An artery which is named anterior cerebri, as belonging to the fore part of the brain. But the vertebral, as it arises through the occipital hole, lies upon the cerebellum, and supplies all the cerebellum, and also the back part of the brain. One branch goes to the back part of the cerebellum, another to the fore part of the cerebellum, a third branch goes to the back part of the brain; and thus there is formed betwixt the carotid and the vertebral, by means of the great inosculation of the circle of Willis, one great set of vessels; which should first of all be described free from all the interruptions of trivial arteries, which go off from point to point, but of which the destinations

tions cannot be important, which are hardly known, which do not go in any two subjects the same way.

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## OF THE INTERNAL CAROTID ARTERY.

The internal carotid artery leaves the external carotid at the angle of the jaw: it is so inclined to contortions, that at this point it even bulges, and seems the outermost of the two. In mounting along the neck, it is tied by cellular substance to the fore part of the rectus or straight muscle of the neck, and it is also connected with the par vagum and intercostal nerve; the ganglion of the intercostal, or sympathetic nerve, lies by its side; the nerve, before it forms this ganglion, comes down small and thread like through the same canal by which the carotid passes into the skull.

The contortions of the carotid are great, both before and after its passage through the bony canal; but within the canal it is forced to particular and successive bendings, such as indicate plainly some design of Nature; for the canal for the artery is long and tortuous, while the nerves and veins pass through plain and simple holes. When the carotid first presents itself to enter the skull, it is curved, and is a little behind its hole; it bends forwards and inwards a little, and so enters the canal; in entering the canal it rises almost perpendicularly upwards, but soon bends forwards again, lying, as it were, upon the floor of the canal; then it bends again upwards and forwards, to emerge from the canal; by which turn the portion of the artery

artery which is engaged in the canal has the form of an Italic *ſ*. Even after it gets into the skull, it must still bend once more sidewise and forwards, as if to meet its fellow, and to get to the side of the sella turcica; then it goes directly forwards till it touches the anterior clynoid process; and then doubling back, or returning upon itself, it rises perpendicularly; and so perpendicular is this last turn, that when cut across, the mouth of the artery gapes perpendicularly upwards: here it begins to give its branches to the brain.

It is by the side of the sell a turcica that the CAVERNOUS SINUS surrounds the artery. This sinus is formed by the two plates or lamellæ of the dura mater, parting from each other, and leaving an interstice full of cells, like those of the penis or of the placenta. It is filled with blood, by communication with several of the smaller sinuses or veins about the basis of the brain: the opthalmic veins bring into it the blood from the eye; four or five small veins descending from the fossa Sylvii bring blood into it from the middle parts of the brain; the sinuses of the os petrosum (both on its upper and lower grooves) open into it, one high, another lower down, and that circular sinus or vein which surrounds the root of the optic nerves opens into it from either side. All this blood is poured into the cells, bathes the carotid artery which lies naked in it; and by the side of the carotid artery lies also that small nerve of the sixth pair which begins the great intercostal nerve, naked in the blood; it is tinged by the blood, and its branches retain the tinge some way down the neck.

Veussens

Veussens first discovered this curious structure; Ridley denied it, and Haller at last in his turn confirmed it. Veussens believed that the sinus which deposited this blood conveyed it away again. Haller says that this is the peculiar office of that vein which accompanies the carotid artery, and which is named the vena sodalis arteriæ carotidis. It was once supposed that certain small arteries opened also into the sinus; but it has neither arteries, nor pulsation.

Thus we trace the carotid through its canal, through the cavernous sinus, up to the side of the sella turcica, and about to enter the brain, to give off the arteries of the brain. But before we describe these, it will be easy to count shortly those little twigs which it gives off in the canal and in the sinus.

The carotid artery seldom gives out arteries before it enters the skull; it is a lusus naturæ, when it does happen that the occipital or pharyngeal arteries come off from it.

The first twig, which in any case it gives off, is sometimes a small artery, which returns downwards along with the upper maxillary nerve *; next a small twig, accompanied by a branch from the meningeal artery, goes into the tympanum by way of the aquæ ductus Fallopii; and next, while the artery is within the sinus cavernosus, it gives out two little branches, the one forwards the other backwards, named ARTERIES of the RECEPTACULUM.

1. The little artery which goes backwards from the sinus or receptaculum goes chiefly to that part of the

* The second branch of the 5th pair.

dura mater which covers the posterior clynoid process, and which covers the cuneiform process of the occipital bone; it gives twigs to the 4th, 5th, and 6th pair of nerves and to the pituitary gland; in short, to all the parts at the back of the sella turcica; it ends in inosculations with those twigs of the vertebral artery, which come off from the vertebral before it enters the skull.

2. The little artery which comes out from the receptaculum to go forwards, arises where the carotid is crossed by the 6th pair, mistaken for a nerve by those who suppose that the intercostal arises from a branch of the 5th pair. The distribution of this little artery is nearly the same with that of the first, for it belongs to the 3d, 4th, and 5th pairs of nerves, and to the pituitary gland.

The carotid having risen to the anterior clynoid process, gives out there a small artery, no bigger than a crow-quill, which enters directly into the orbitary hole, accompanies the optic nerve into the eye, furnishes the eye, the eyelids, the muscles, and the lachrymal gland, and sends out branches upon the forehead, viz. the frontal arteries in which it ends. This is a short history of the OPHTHALMIC ARTERY; which, as it furnishes all the arteries of the eye, must be described apart.

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### DIVISION OF THE INTERNAL CAROTID.

The carotid, now about to enter into the brain, divides at the sella turcica into three arteries; one to

to the fore lobe, another to the middle lobe, and a third to form the circle of Willis. These arteries are usually so numbered that the communicating branch is first described, next the anterior artery of the brain, and lastly the middle artery of the brain. But of this arrangement no one who is accustomed to observe the course of this artery can entirely approve; for when the carotid rises from the side of the sella turcica, it divides into its three branches all at once, in a tripod-like form: the middle branch of the tripod is largest; the next, which goes forwards to the fore lobe of the brain, is smaller; the third, which is the communicating branch, going backwards to unite with the vertebral artery and form the circle of Willis, is the smallest of all. The middle artery of the brain then is, from its great size, to be regarded as the trunk.

### 1. ARTERIA MEDIA CEREBRI.

THE middle lobe of the brain is separated from the anterior lobe by a very deep sulcus or furrow, which is named FISSURA SYLVII. This fissura Sylvii is formed by the transverse process of the sphenoid bone, or, in other words, by that very sharp line which runs out laterally from each of the clinoid processes, and which parts the fore lobe, which lies in the shallow part of the skull upon the orbitary processes of the frontal bone, from the middle lobe, which is the largest of all, and lies in the deepest part of the skull behind the clynoid processes. The MIDDLE ARTERY OF THE BRAIN having risen from the side of the sella turcica, runs straight along this fossa Sylvii, and is really

the continued trunk of the carotid; it is larger than the artery at the wrist; it goes directly outwards, viz. towards the temple; it runs along the fossa Sylvii, and is lodged deep in that cleft; where it lies deep, it divides into two great branches, one deep and one superficial; it gives some branches to the anterior lobe, but it is chiefly limited to the middle lobe of the brain; its branches to the posterior lobe, or inosculations with any branches of the basilar artery, are comparatively few.

Thus the artery ends by passing into the substance of the brain. But nearer the sella turcica and before it enters into the fossa Sylvii, it gives some small and delicate arteries; the consideration of which seems to be unimportant at first view, but which is really useful in explaining the anatomy of the brain. It gives small twigs to the pituitary gland, to the optic nerve, to the tentorium, and especiallyto the pia mater covering the basis of the brain. Among these small twigs certain sets of arteries make a very distinguished figure.

1. There is one small artery which runs up into the anterior horn of the lateral ventricle, and forms that great plexus which lies along the floor of the ventricle, named PLEXUS CHOROIDES. This, then, is the ARTERY of the CHOROID PLEXUS.

2. There is a set of arteries, of considerable number, but varying in respect of number, small as sewing threads, which inosculate repeatedly with each other, and which are scattered widely and beautifully over the crura cerebri and basis of the brain, forming in the pia mater a plexus or web of vessels. This part of

of the pia mater is named velum from its beauty and delicacy; and this is what Wepfer, among other older authors, considered as a species at least of the rete mirabile: but that name implies a peculiar office, as in beasts, which this delicate net-work of vessels cannot have.

### 2. ARTERIA ANTERIOR CEREBRI.

THE FORE ARTERY of the BRAIN comes off from the middle artery at right angles nearly; for the great or middle artery runs directly outwards towards the temple, while this second artery runs directly forwards along the fore lobe of the brain. It is named sometimes the artery of the corpus callosum, because that of two great branches into which it is divided one goes to that part of the brain. The corpus callosum ( a most absurd name for any part of the brain ) is the white and medullary substance where the two hemispheres of the brain are joined; and upon separating the two hemispheres with the fingers, the corpus callosum is seen like a large white arch, and the artery of the corpus callosum is seen also arching over its surface.

The anatomy of the arteria anterior cerebri may therefore be explained thus: First it goes off at right angles from the middle artery of the brain, which is to be considered as the trunk, and there it often gives small twigs to the olfactory and optic nerves: next the two anterior arteries of each side, while they go forwards as if towards the crista galli, bend a little towards each other; they almost meet, but

do not absolutely touch; they form a communication with each other, which of course is exceedingly short, but pretty large. It is this short communication which completes the circle of Willis at its fore part. This cross communication betwixt the arteries of the opposite sides passes just before the sella turcica and pituitary gland, and exactly in the middle it sends off an artery, which goes down into the third ventricle, and gives branches to the fore part of the fornix and to the septum lucidum.

After this communication, both arteries rise, with a large sweep along the flat surface of that deep division which the falx makes betwixt the two hemispheres of the brain; there each divides into its two great branches; one attaches itself to the corpus callosum, or that arch which we see upon holding apart the two hemispheres; it arches along with the corpus callosum so as to describe a semicircle; It is the larger of the two branches; it it named ARTERIA CORPORIS CALLOSI: the other branch keeps upon the flat surface of the brain, where the one hemisphere lies flat upon the other, and it rises in a beautiful arch within the pia mater, dividing into beautiful and very minute ramifications before it enters actually into the substance of the brain.

These two great branches of the anterior artery are well distinguished by Wepfer by the names of arteria profunda and arteria sublimis (the deep and superficial of the anterior artery), as there is a deep and a superficial branch of the middle artery. The arch of the arteria anterior cerebri overhangs in a manner that of the artery of the corpus callosum, and both of them

them inosculate under the falx with the arteries of the opposite side.

### 3. ARTERIA COMMUNICANS.

THE COMMUNICATING ARTERY goes as directly backwards from the middle artery as the anterior artery goes forwards. It is small, proceeds backwards, and a little inwards; it goes round the sides of the corpora mamillaria, and is about a quarter of an inch in length before it meets the vertebral artery; and though it does give off small twigs, as to the infundibulum, to the optic nerve, to the crura cerebri, and especially one of greater size, to the choroid plexus; yet all these are trivial arteries, such as every trunk at the basis of the brain gives off. It is not its twigs that are to be observed, but itself only that is important, as forming one of the largest and most important inosculations of the body. It unites the middle artery of the brain, which is the trunk of the carotid, with the posterior artery of the brain, which is the first and greatest branch of the vertebral artery.

This anastomosis is the circle of Willis, too remarkable not to have been very long observed; it was drawn by Veslingius and by Casserius; it is but ill represented by Bidloo and by Cowper; it is not a circle, but is right lined, and of course angular: it is of very unequal size; in one body it is large, in another smaller, often even in the same body; it is irregular, the one side being large and the other small.

This inosculation brings us round to the first of the vertebral arteries, viz. the ARTERIA POSTERIOR CEREBRI;

BRI; for the vertebral artery gives two arteries to the cerebellum, and one to the back part of the brain.

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## OF THE VERTEBRAL ARTERY.

THE vertebral artery, though but the secondary artery of the head, is a principal one of the brain, and conveys a very great proportion of blood; and its turnings and windings before it enters the skull are almost as particular as those of the carotid itself. The vertebral is among the first branches of the axillary artery, and comes off from it where it lies across the root of the neck. The two lower ganglions of the sympathetic nerves lie over it, and their threads surround its trunk, making curious net-works round it. The artery then enters into the canal prepared for it in the transverse processes of the vertebra, commonly getting in by the 6th vertebra; but in this it is irregular sometimes entering into the 7th or lowest; and it has been seen entering into the uppermost hole but one. In this canal it ascends in a direct line from the bottom of the neck to the top; but like the carotid it makes great contortions before it enters the skull; for when it has reached the second vertebra, its transverse process being rather longer than those of the lower vertebræ, the artery is forced to incline outwards; and the transverse process of the atlas or first vertebra being still much longer, the artery in passing through it is carried still farther outwards;

wards; it is forced to make a very sudden turn, and is quite exposed. When the artery has passed through the transverse process of the atlas, it makes another very sudden turn, lies flat upon the circle of that vertebra, so as to make a large hollowness or groove upon the bone, and then it enters the foramen magnum by rising in a perpendicular direction; and then again it bends and inclines forwards, laying flat along the cuneiform process of the occipital bone, where it soon meets its fellow, and the two uniting form the basilar artery.

This basilar artery lies, with regard to the bone, upon the cuneiform process of the os occipitis, and runs along it from the foramen magnum to the sella turcica; with regard to the brain, it lies upon that great tubercle which is named the tuber annulare or pons Varolii; as it lies upon the tuber annulare, it marks it with a large furrow; and as it goes along in one great trunk, it gives out from each side little arteries, which belong to this tuber annulare. These also make smaller furrows on its surface.

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The vertebral artery has, like the carotid, its three great branches.

### 1. ARTERIA CEREBELLI POSTERIOR.

THE POSTERIOR ARTERY, OF LOWER ARTERY of the CEREBELLUM, is small and not regular. It comes off from the basilar artery either immediately after the union of the vertebrals, or from the vertebral artery immediately

immediately before the union. It is often smaller on one side than on the other, and sometimes it is wanting on one side. It moves downwards in a sort of retrograde course betwixt the accessory nerve of Willis and the group of fibres which form the eighth pair, and dives in betwixt the cerebellum and the medula oblongata. Its larger branches spread out upon the pia mater, and then enter into the medullary substance. They belong to the cerebellum, to the spinal marrow, and some of them to the pons Varolii. But there are also smaller and particular twigs, as twigs to the eighth and ninth pairs of nerves: one also which enters into the fourth ventricle, to form a sort of velum or choroid plexus there: and as this posterior artery winds downwards under the cerebellum, it gives many branches about the vermis, and small twigs which run betwixt the lower point of the pons Varolii and the pyramidal bodies.

Next the ARTERIA BASILARIS proceeds forwards along the pons Varolii in one great trunk: now the pons Varolii is just the tuberosity produced by the crura cerebri and cerebelli, meeting and uniting to form the spinal marrow. The corpora olivaria and pyramidalia are just two bulgings at the root of the spinal marrow; and as every great artery, whatever its destination may be, gives twigs to those parts which it passes over, so does the basilar artery; giving twigs first to the corpora olivaria and pyramidalia, next to the crura cerebelli and to the crura cerebri; and as it runs along the pons Varolii it distributes little arteries to it from right to left. These little arteries also mark the sides of the pons with small furrows, which are seen when

when the arteries are dissected away. One of these transverse arteries, longer than the rest, looks like another posterior cerebri. It goes to the seventh pair, or auditory nerve, in the following way: The seventh pair of nerves proceeds from the back part of the pons Varolii; and as it goes forwards, the two nerves which it consists of, viz. the portio dura and the portio mollis, are separated from each other by a small and very beautiful artery which shoots in betwixt them, and enters along with them into the ear. The basilar artery also gives twigs to the fifth and sixth pairs of nerves which arise from the fore part of the pons, as the seventh pair arises from behind.

Arrived at the fore part of the pons Varolii, the vertebral artery gives off almost at one point four great arteries, two to the right hand and two to the left. These are the anterior cerebelli and the posterior cerebri.

## 2. ANTERIOR CEREBELLI.

THE ANTERIOR ARTERY of the CEREBELLUM, or the upper artery as it is called, goes off at right angles from the basilar artery, and bends round the crura cerebri to get to the cerebellum. It gives its branches first to the crura cerebelli, to the cerebellum, and to the vermis. Secondly, There is a greater artery going over all the upper part of the cerebellum, (where it lies under the brain), and also another which keeps closer to the brain than to the cerebellum, branches over that velum or delicate part of the pia mater which is interposed betwixt the cerebellum and brain; and going

going along it supplies the crura cerebri, and arrives at last at the place of the nates, testes, and pineal gland, and attaches itself to them. Some of the twigs go down into the fourth ventricle.

### 3. ARTERIA POSTERIOR CEREBRI.

THE POSTERIOR ARTERY of the brain goes off immediately after this, is like it, runs parallel with it, is larger, goes to the posterior lobe of the brain, and receives near its root the communicating artery from the carotid, which forms the circle of Willis. Where this posterior cerebri and the anterior cerebelli run parallel with each other, the third pair of nerves rises betwixt them. The posterior cerebri first gives a small twig on either side to the bottom of the third ventricle which runs so far forwards as to give branches to the thalami, centrum geminum, infundibulum, and to the crura fornicis. Then the main artery bending like that last described round the crura cerebri, and passing deep into the great division betwixt the cerebellum and brain, arches upwards towards the back lobes of the brain; but before it arrives there, it gives first small twigs to the crura cerebri, and then another notable artery (though small) destined for the internal surfaces of the ventricles. This is a chief artery of the choroid plexus; it enters the lateral ventricle by the posterior horn; goes along with the cornu amonis: helps to form the choroid plexus; inosculates, of course with the choroid arteries from the carotid; and twigs also go from this artery to the nates, testes, and pineal gland, or in other words, to the velum which separates

rates the cerebellum from the brain, which closes the ventricle behind, and which covers the pineal gland, and is a membrane or velum to it also; the pineal gland, nates, and testes, being situated neither in any of the ventricles, nor on the surface of the brain, but betwixt the surface of the brain and cerebellum, where the one lies upon the other.

After this second branch to the internal surfaces, the great trunk of the posterior cerebri branches profusely like a tree all over the back part of the brain, inosculating forwards with the middle artery of the brain, and also with the artery of the corpus callosum.

Thus is the whole brain supplied with blood; and next in order come the arteries of the spinal marrow.

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## §. 2. OF THE ARTERIES OF THE SPINAL MARROW.

I HAVE mentioned none of those smaller arteries which the vertebral gives off before entering the skull, because being destined chiefly for the spinal marrow, they belong to this second class.

The vertebral artery, as it mounts along its canal towards the head, gives at each step, or as it passes each vertebra, a delicate twig; these little arteries pass through the intervertebral spaces, go to the deeper muscles

muscles of the neck, and inosculate with the thyroid and cervical arteries. In like manner, other small arteries go inwards to the spinal marrow at the place where each nerve comes out. They enter into the sheath of the spinal marrow, and inosculate with the chief arteries of the medulla spinalis.

As the vertebral passes through the atlas, both above and below that bone it gives out much larger arteries to the muscles, as to the recti, trachelo-mastoideus, and complexus, inosculating largely with the occipital artery: often there is at this point one large and particular artery going out to the back of the neck.

Again, as the vertebral passes through the occipital hole, it gives out a little artery, which accompanies the trunk itself up through the foramen magnum, and goes to that part of the dura mater which covers the cuneiform process, and there it inosculates with the twig of the carotid, which enters along with the jugular vein. This is the posterior artery of the dura mater.

Next come the arteries of the spinal marrow, the anterior of which comes out from the trunk of the vertebral artery; the posterior (though it also sometimes comes off from the vertebral before the basilar is formed) more commonly comes off from the posterior cerebelli.

### 1. ARTERIA ANTERIOR MEDULLÆ SPINALIS.

THE ANTERIOR ARTERY of the spinal marrow is the larger of the two. It was discovered first by Willis; it had

had been looked upon, till the time of Veussens, as a nerve accompanying the spinal marrow; because, when empty of blood and uninjected, it is white, and not unlike a nerve. This spinal artery begins within the skull by two branches, which unite as they proceed down the spine. These two branches arise one from each vertebral artery, at the very point where the vertebrals are about to unite to form the basilar trunk: each artery passes down its own side of the spinal marrow, betwixt the corpora olivaria and the corpora pyramidalia; each artery, before it leaves the skull gives twigs to the tuber annulare, and to the pyramidal and oval bodies, for they are the beginnings of the spinal marrow; and soon after emerging from the skull *, the two spinal arteries join so as to form one anterior spinal artery. This joining is usually at the top of the neck, or rather within the skull, but sometimes so low as the last vertebra of the back. Almost always they join within the head or near it; and the anterior spinal artery which they form descends along the spinal marrow in a furrow which it forms for itself. The peculiar office of this artery is to supply the spinal marrow and its sheath, which it does by sending continual branches into the substance of the spinal marrow; while other branches go into the sheath itself, and pass out from the spinal canal along with those nerves which go out from the spinal marrow, ac-

* The artery which accompanies the ninth pair or lingual nerve, often comes from the anterior spinal artery.

companied

companied by little processes of the sheath, which are named processi denticulati.

But this artery, being extremely small, would be soon exhausted, were it not reinforced with small arteries coming into the sheath: these pass through the vertebral interstices into the spinal canal, and are derived from every artery that passes near the spine. Thus in the neck the spinal artery receives twigs from the vertebral arteries, and from the thyroid and cervical arteries; in the back it receives twigs very regularly from each of the intercostal arteries, and it receives its twigs from the lumbar arteries when it has got down as low as the loins.

But this spinal artery which is continually diminishing, at last fails in the loins; and where the cauda equina begins, viz. in the canal of the os sacrum, the medulla is no longer supplied by a spinal artery, but by the small branches of the sacral arteries, which enter by the ten holes of the sacrum.

Of those adventitious branches which reinforce the artery of the spinal marrow as it descends through the spine, each gives several other branches; they give twigs to the muscles of the spine, twigs to the substance of the vertebræ themselves, twigs to the sheath of the spinal marrow; and, finally, twigs which inosculate with the spinal artery, and which sink into the nervous substance to nourish it.

### 2. ARTERIAS SPINALIS POSTERIOR.

THE POSTERIOR SPINAL ARTERY differs in all essential points from the anterior: First, There are two posterior

posterior spinal arteries which arise, not from the basilar or vertebral arteries like the anterior, but usually from the arteria anterior cerebri; and they are smaller than the anterior spinal artery: Secondly, These two arteries give small twigs to the bottom of the fourth ventricle, and then go round from the fore to the back part of the medulla oblongata; but there, instead of uniting like the beginnings of the anterior artery, they continue separate, run down the spinal marrow as two distinct arteries, with very frequent inosculations betwixt them. This artery is also unlike the other in respect of its termination, for it disappears at the second vertebra of the loins. Its inosculations with the arteries from without are very free.

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## §. 3. ARTERIES OF THE EYE.

The arteries of the eye come from one branch only, the ophthalmic artery, the branch which the carotid, when it touches the anterior clynoid process, sends into the orbit along with the optic nerve. But small as this original artery is (no bigger than a crow-quill), the system of arteries which arises from it is very great; whether we consider their number, the irregular parts which they supply, or the great inosculations which they form even with the outward arteries of the nose and face.

These are reasons for setting this order of arteries apart; and even with all possible care in the arrangement, it is not easy to deliver an orderly intelligible history of this artery. The ophthalmic artery supplies not only the eye itself, i. e. the globe, but it supplies also all the apparatus, if I may so call it, of the eye, i. e. the muscles, the lachrymal gland, the eye-lids, and even the forehead and nose.

1st, It sends a great branch, which leaves the ophthalmic artery, and takes its own course outwards and upwards along the eye, to supply the lachrymal gland where it is exhausted. 2dly, The ophthalmic supplies the eye itself, both by that artery which enters into the centre of the optic nerve, called arteria centralis retinæ, and also by other arteries which are named the ciliary arteries; because they go onwards to the fore part of the eye, where the ciliary circle is. 3dly, The muscles are supplied by an artery which comes from the same place nearly with those ciliary arteries. 4thly, There are two arteries which go down through holes in the socket into the bones and cavities of the nose; and these, as they perforate chiefly the æthmoid bone, are named æthmoidal arteries. 5thly, and lastly, Those arteries which go out upon the forehead and nose are so directly from the trunk of the ophthalmic artery, that they must be regarded as the termination of it. This is the system of vessels which comes now to be described, and this is, perhaps, the best order for the description.

FIRST

## FIRST ORDER.

### 1. ARTERIA LACHRYMALIS.

THE LACHRYMAL ARTERY is the first branch of the ophthalmic; but, in order to know its place correctly, we must first observe how the ophthalmic artery enters the eye. It comes off from the carotid, where that artery touches the clynoid process; and is so close upon the process, that the setting off of the ophthalmic is almost covered by that projection. It then dives under the optic nerve, and appears on the outer side of it; and as the artery goes along through the orbit, it makes a spiral turn till it completely surrounds the nerve.

The lachrymal artery goes off from the ophthalmic immediately after entering the orbit*, though sometimes it arises from the artery of the dura mater; and then it enters by the foramen lacerum, which is the next opening to the optic hole. It goes off from the ophthalmic about two or three lines after it has entered the socket. It goes all along the outer side of the orbit, because the lachrymal gland lies in the outer corner of the eye. When it reaches the gland, it is branched out and entirely expended upon it, except that it sends some small twigs forwards to the eyelid.

* Sometimes it goes off one or two lines before the ophthalmic enters the optic hole, sometimes from the middle of the artery.

Of these vagrant branches, one twig goes to the periosteum of the orbit, perforates the cheek bone, and so gets into the hollow of the temple, inosculating with the deep temporal artery; while another little branch goes to the tarsus of the upper eyelid, and another to the tarsus of the lower eyelid, and thus ends the lachrymal artery.

## SECOND ORDER.

In the second order are included the arteries which go to the eye itself, viz. the ARTERIA CENTRALIS RETINÆ, and the CILIARY ARTERIES; of which arteries there is none more curious than the arteria centralis retinæ.

### 1. ARTERIA CENTRALIS RETINÆ.

This artery is so named because it perforates the optic nerve, runs up through its very centre or axis, enters into the cavity of the eye through the very centre of the optic nerve, and spreads its branches all over the retina. It usually arises from the ophthalmic artery, where it turns in the middle of the orbit over the upper part of the optic nerve*; it plunges into the nerve; and this artery, or rather the artery and vein, both (for the vein accompanies it) make so large a canal in the centre of the optic nerve,

* It may be found arising from the ciliary arteries, or sometimes from the muscular.

that

that it stands quite open and gaping when the nerve is cut across; and was long known to the older anatomists by the name of porus opticus, before the meaning of this orifice or hole was understood.

When this artery arrives within the eye, it branches out most beautifully upon the retina. The angles and meshes which this artery makes give the name of retina or net-like to the whole; for the pulpy part of the optic nerve expands into a very thin and delicate web which resembles mucus. This web has all its strength from these branches of the central artery. The branches of the artery, and the mucus-like expansion of the nerve, lie in two separate layers; and hence some anatomists reckon the retina a double membrane.

The arteria centralis having given off sidewise these innumerable branches to the retina, still goes forwards, plunges through the substance of the vitreous humour, does not stop till it arrives at the back part of the lens, and is of course the ARTERIA CENTRALIS OCULI, the central artery of the eye itself. This central artery can no more be seen in the adult eye than the arteries of an unprepared bone; but by injecting the small arteries of the eye of a fœtus, of a slink Calf, or of any young animal, the arteria centralis oculi is found to distribute its branches in the following way; As it goes forwards through the centre of the eye-ball, it gives off its delicate arteries from side to side, which go along the partitions of the vitreous humour (for the vitreous humour is divided every where by membranes into small honeycomb-like cells.) These

 cross

cross arteries inosculate with those of the retina, and are plainly the arteries which secrete and support the vitreous humour. The central artery stops when it comes to the back of the lens: it is scattered in a radiated form, as if by the resistance, into a great many branches. These branches go round all the capsule of the lens, and meet again on its fore part; where, uniting into one or more small arteries, they pass onwards into the opening of the pupil, and help to form that membrane which in the fœtus shuts out the light, protects the eye, and vanishes very gradually.

So the arteria centralis retinæ passes first through the centre of the optic nerve; next through the centre of the vitreous humour; next, after going round the capsule of the lens, it passes through the posterior chamber of the aqueous humour, and terminates in the centre of the pupil. But as these last arteries, viz. of the pupil, vanish soon after birth, we may consider the central artery as ending in inosculations with those arteries, which coming upwards along the sides of the eye along with the retina, form a strong circle of arteries at the root of the ciliary process.

## 2. ARTERIÆ CILIARES.

The ciliary circle is known, upon looking outwardly at the eye, by that white line which borders the iris, and separates the iris or coloured part of the eye from the white or colourless part. That circle marks the place where there is a great concourse of arteries. The corpus ciliare, or ciliary body, is the part within the

the eye which lies flat upon the fore part of the vitreous and crystalline humours, which is like a second iris behind the first, which is extremely vascular, and corresponds with the ciliary circle without. This corpus ciliare is radiated (that is a consequence of the peculiar order and arrangement of its vessels, which run in rays from the ciliary circle, *i. e.* from the circumference towards the centre.) These radii coming from the ciliary circle are called the ciliary processes; so that the ciliary circle, corpus ciliare, and ciliary processes, are all parts of the same vascular organ. This is the part of the eye to which all those arteries go which are next to be described.

1. Two arteries of considerable size go off from the sides of the ophthalmic artery: these go along the sides of the optic nerve; they go towards the ball of the eye; and the one on the outer side of the eye is named EXTERNAL CILIARY ARTERY, that on the inner side of the optic nerve is named the INTERNAL CILIARY.

2. These two divide themselves again into two subordinate branches: one of them as soon as it touches the eye, that is, just beyond the implantation of the optic nerve, enters its substance, and is spread out on its choroid coat in a great number of branches, which are named CILIARES BREVES, the short ciliary arteries: the other goes further forward upon the eye before it enters, and even after it enters it still goes forwards to the very fore part of the eye before it divides; hence named CILIARES LONGÆ.

3. The ANTERIOR CILIARY ARTERIES are some small and uncertain branches, which come sometimes

from one source, sometimes from another, but most commonly from the muscular branches; and they go along with the muscles, and consequently enter the eye at its fore part just where the recti muscles are inserted. But, though small, these anterior ciliary arteries are of considerable number.

From the places at which these several arteries enter the ball, one might guess a priori how they will be distributed through its coats.

First, The short ciliary arteries do not all of them arise from the ciliary trunk; but of this great number of very small arteries, many arise from the muscular branches. As soon as they touch the eyeball, they enter into it near the insertion of the optic nerve, pass through the sclerotic coat (leaving for its nourishment a few twigs; they divide so, that just after they have entered, we can count twenty-five or thirty all round the root of the optic nerves, which go forwards in a radiated form, and are completely diffused upon the choroid coat, which they cover with an inner membrane, or rather tissue of vessels, named tapetum, or tunica Ruysehiana. This coat of vessels lines the choroid all the way forward to the lens, goes still onwards to the fore part of the lens; and then turning down upon the lens at right angles, it meets with the anterior vessels, and forms the ciliary circle, and the ciliary processes or radii, which are about thirty; so that the short ciliary arteries having formed about thirty branches in entering at the back part, they now terminate by a like number at the fore part, of the eye. A few twigs go still forward upon the

the uvea and iris, so as to make a very important connection of all the vascular parts of the eye.

Secondly, The LONGER CILIARY ARTERIES enter the sclerotic a little further forward, penetrate at a greater distance from the optic nerve, they penetrate the sclerotic a little before its middle; but still they continue entire, or they give but very small branches. When they approach the ciliary circle, they divide into two or three long arteries, which go off at right angles, embracing a corresponding quarter of the ciliary circle: from these arms their branches meet each other, and are now joined both by the shorter ciliary arteries and by the anterior ciliary arteries; by which conjunction an arterial circle is formed which corresponds with the outer circle of the uvea, and is called the OUTER CILIARY CIRCLE: this again sends radii of vessels, perhaps thirty, inwards, which meeting form a second circle, the INNER CILIARY CIRCLE.

Thirdly, The anterior ciliary arteries again enter the eye at its fore part, and immediately unite with these, as has just been explained; they help to form the ciliary circle, which is the great conjunction of all the internal vessels of the eye.

## THIRD ORDER.

IN this order are included the MUSCULAR ARTERIES, which are the least regular of all the branches of the ophthalmic artery. From one or other branch of the ophthalmic

ophthalmic there generally arise two muscular arteries; the one for the upper, the other for the lower muscles.

### 1. ARTERIA MUSCULARIS SUPERIOR.

THE UPPER MUSCULAR ARTERY consists of small twigs, which go chiefly to the levator palpebræ and rectus superior; and these, though they sometimes arise as two small twigs from the ophthalmic artery itself, yet in general come off rather from that artery which, as it goes out by the supra-orbitary hole, is named the supra-orbitary artery. These muscular branches of the supra-orbitary, then, supply the upper muscles of the eye, as the levator palpebræ, the obliquus major, the rectus superior, and the sclerotic or outer coat of the eye.

### 2. ARTERIA MUSCULARIS INFERIOR.

THE LOWER MUSCULAR ARTERY is very generally an independent artery, and pretty large. It comes off from that part of the ophthalmic artery where it is giving off the ciliary arteries. This muscular branch is large enough to give off sometimes the arteria centralis retinæ, and often some of the short ciliary arteries arise from it; it is so long as even to reach the lower eyelid. The muscles which it supplies are all those which lie on the lower part of the eye, as the deprimens oculi, abducens oculi, obliquus minor. It also gives variable twigs to the sclerotica, the optic

optic nerve, the periosteum of the orbit, and sometimes to the adnata and lower eyelid.

## FOURTH ORDER.

THE set of arteries which stand next in order are those which go down into the nose through the æthmoidal bone, whence they are named æthmoidal arteries. The æthmoidal arteries are, like the other branches of the ophthalmic, pretty regular in their destination, but far from being regular in the manner in which they arise.

### 1. ARTERIA ÆTHMOIDALIS POSTERIOR.

THE POSTERIOR ÆTHMOIDAL ARTERY is so named because it passes through the posterior of two holes which are in the orbit at the joining of the æthmoidal with the frontal bone*. It is an artery by no means regular in its place, coming sometimes from the ophthalmic trunk, sometimes from the lachrymal artery, very rarely from the supra-orbitary artery. It is of no note: it is the smaller of the two æthmoidal arteries; it goes through its hole, and is scattered upon the bones and membranes of the nose. While it is circulating its twigs among the æthmoidal cells, it

* In describing the skull, these are named the internal orbitary holes.

inosculates,

inosculates, of course, with the nasal arteries of the external carotid.

### 2. ARTERIA ÆTHMOIDALIS ANTERIOR.

THE anterior æthmoidal artery is rather more regular and more important; it passes through a larger hole, and is itself larger; it comes off more regularly from the ophthalmic trunk, and it goes not down into the nose, but upwards into the skull.

The ophthalmic artery, much exhausted by giving off many branches, has risen over the optic nerve, has completed its spiral turn, and has just got to the inner corner of the eye, where the æthmoid hole is, when the anterior æthmoid artery arises from it. It arises just behind the pully of the upper oblique muscle, plunges immediately into its peculiar hole, and, passing along a canal within the æthmoid bone, it merely gives twigs to the frontal and æthmoidal sinuses, and passes up by one of the largest holes in the cribriform plate of the æthmoid bone. When within the skull, it is under the dura mater, betwixt it and the bone; it goes to the dura mater and to the root of the falx, and some of its delicate twigs turn downwards again into the nose, through the small holes of the cribriform plate accompanying the branches of the olfactory nerve.

## FIFTH ORDER.

THE fifth order of arteries is very numerous, including all those which send their twigs outwards

upon

upon the face. They are the supra-orbitary artery, the artery of the upper eyelid, the artery of the lower eyelid, the artery of the forehead, and the artery of the nose.

### 1. ARTERIA SUPRA-ORBITALIS.

The supra-orbitary artery is so named from its emerging from the socket by that notch in the superciliary ridge which we call the supra-orbitary hole. It comes off from the ophthalmic artery at the place where it gives off the ciliary and lower muscular arteries: it so often gives off the arteries which go to the upper muscles of the eye, that some have named it the superior muscular artery. It passes onwards, giving twigs to the levators of the eye and of the eyelid, and to the upper oblique muscles, and to the periosteum; and before it arrives at the supra-orbitary hole, it divides into two twigs; of which one lies deep, and supplies the periosteum of the forehead, inosculating with the temporal artery; the other lies more superficial, but still is covered by the orbicularis and corrugator supercilii, on which muscles it bestows all its branches.

### 2. ARTERIÆ PALPEBRALES.

The two palpebral arteries arise from the ophthalmic after it has passed the tendon of the obliquus superior, when it has in a manner emerged from the socket, and is lying at the inner angle of the eye: there it commonly gives off two small arteries, one to the

the upper and one to the lower eyelid; and often the two arise by one trunk.

ARTERIA PALPEBRALIS INFERIOR.—The ARTERY of the LOWER EYELID is the branch of the two which goes off the first; but it is the smaller and less regular of the two. Its twigs go one to the union of the two tarsal cartilages, to the caruncula lachrymalis, and to the adjoining part of the adnata; another goes deeper, viz. to the lachrymal sac, and even into the æthmoid cells; and a third twig runs along the margin of the tarsus, named tarsal artery, supplying the Maibomian glands.

ARTERIA PALPEBRALIS SUPERIOR.—The ARTERY of the UPPER EYELID arises along with the lower palpebral or near it; it gives few branches; one keeps to the angle of the eye, and supplies the orbicularis oculi, the caruncula, and the tunica conjunctiva; another having pierced the fibres of the oblique muscle, runs along the borders of the tarsus inosculating with a similar branch of the lachrymal artery, and forming an arch along the upper tarsus as the other does below.

### 3. ARTERIA NASALIS.

THE NASAL ARTERY goes off at the edge of the orbit, rises over the lachrimal sac, and over the ligament of the eyelids; it first gives a twig upwards to the root of the frontal muscle; then another goes down over the lachrymal sac, and after giving branches to the sac, goes to the orbicularis muscle, and inosculates with the infra-orbitary artery; and lastly, the most

most remarkable branch of this artery, from which indeed it has its name, runs down upon the side of the nose, making a beautiful net-work, and inosculating with the last branch of the labial artery which runs up to meet it*. This is quite a cutaneous artery; many of its twigs go to the skin; it is felt beating strongly; it was often opened when arteriotomy was more regarded than it is now.

### 4. ARTERIA FRONTALIS.

THE FRONTAL ARTERY is now to be distinguished from the supra-orbital; for the supra-orbital rises deep in the socket, emerges by the supra-orbitary hole, passes along chiefly betwixt the bone and muscles, and makes no remarkable figure upon the face; while this, the frontal artery, is larger, keeps chiefly upon the surface of the muscles, is quite subcutaneous, has nothing to do with the supra-orbitary hole, and rises beautifully upon the forehead. It is a delicate and slender artery, not so large as the nasal, and looks like one of its branches; it gives off first a branch to the eyelids, named superciliary artery, which supplies the root of the frontal and the upper part of the orbicularis muscles; it sends an ascending branch which dives under the frontal muscle, and belongs chiefly to the os frontis and pericranium. This is

* Some of its branches absolutely penetrate the cartilages of the nose, and so get access to the Schneiderian membrane, and supply it with blood.

the little artery which often makes a perpendicular groove in the os frontis. The chief branch of the artery continues subcutaneous, is felt beating along the forehead, belongs chiefly to the skin of the forehead and to the hairy scalp, and mounts to the top of the head; to the place of the fontanelle, where it has free inosculations with the temporal artery.

This last branch is the end of the ocular or ophthalmic artery, of which the branches are so irregular in their origin, that the most diligent anatomists have declined that part of the description, and yet have arranged the branches upon that scheme, viz. the points from which the several twigs arise: whereas I have thought it more prudent, since the branches are regular in respect of the parts which they supply, to arrange them according to those parts, viz. the lachrymal gland, the eyeball, the muscles, the æthmoid cells, the face; an order which also very nearly corresponds with the order in which the arteries arise. The learning and remembering these arteries, it is right to acknowledge, is a task more difficult than useful; more suiting the severe anatomist, than the practical surgeon; who yet, if he do his duty, will learn all; and as he learns much, must expect to forget much.

## CONCLUSION.

Before I leave this difficult subject, I stop one moment to explain a point which might leave some confusion

confusion in the reader's mind; and regarding chiefly those little arteries which belong to the membranes of the brain.

It is of great importance in studying the brain, to know the manner in which its membranes are connected with it; and it is especially to be remarked that the internal surfaces, or, in other words, the cavities of the brain, need to be supported, nourished, and supplied with blood as much as the external surface; and that for this end the pia mater turns inwards and lines all the cavities of the brain.

At different points the pia mater and its arteries take various forms, and are called RETE MIRABILE, VELUM, or CHOROID PLEXUS, according to that form.

The RETE MIRABILE has already been explained, as being that division and reunion of the branches of the carotid artery by which the force of the ascending blood is broken before it enters the brain. In many of the lower animals this provision of Nature is most curious and particular; but in Man it would appear, that the erect posture in which he walks, the contortions of the carotid artery as it enters the skull, the manner in which it lies in the cavernous sinus, and, finally, the minute division which it undergoes by spreading over the pia mater before it enters the brain, are sufficient. In Man there is not the smallest vestige of a rete mirabile; and whenever we find a rete mirabile described in Man (as often it has been described), we find invariably that it means no more than the plexus of delicate vessels which go out from the first twigs of the carotid artery, either to supply

 the

the membranes or to enter into the cavities of the brain; and accordingly we find these authors calling it "a beautiful beginning of a rete mirabile;" "an imperfect rete mirabile," &c.

The VELUM, as it is called, is that netted form which the pia mater assumes often about the basis of the brain, whenever the smaller arteries are numerous; for the inosculations of the arteries are like a net-work; the arteries, full of blood or of injection, are opaque and are very apparent; while the membrane upon which they run is lucid, diaphanous, and is scarcely seen. A velum or net of this kind appears on every smooth and uniform surface of the basis of the brain; but the most remarkable of all is that which lies betwixt the brain and the cerebellum. It is named velum interpositum; and at this place insinuates itself (betwixt the brain and the cerebellum) into the back part of the lateral ventricles, where it covers the nates, testes, and pineal gland.

The PLEXUS CHOROIDES again is merely another variety or form of the pia mater. The great choroid plexus is a membrane which lies upon the bottom of each lateral ventricle: it is netted and extremely vascular, not unlike the chorion of some animals, whence it is named. It consists partly of arteries, but chiefly of veins; it conveys some blood to the internal surfaces of the brain, but returns much more.

But although the choroid plexus of the two lateral ventricles be the chief one, the third and the fourth ventricles have each their plexuses or vascular webs. The chief points by which these vascular webs of the

pia

pia mater enter are by the anterior and posterior horns of the lateral ventricles; at which points, and indeed at all the lower parts of the brain, the ventricles must be considered as shut, since these vascular linings, as they enter, adhere on all sides: but may also be considered as open, since they admit these membranes, since they are shut only by their slight adhesion, and may be opened by pulling the parts gently asunder.

This, then, is a general explanation of that vascular part of the pia mater which covers all the basis, and lines all the cavities, of the brain. It is one continuous membrane, under the various titles of rete mirabile, which some older anatomists use; of velum, a name chiefly repeated by Haller; and of plexus choroïdes, a name universally used for that net-work of vessels, which lies out upon the floors of the ventricles. It will be seen hereafter how greatly a knowledge of these inflections contributes to the right understanding of the brain and its parts and cavities.

## CHAP. II.

### OF THE ARTERIES OF THE ARM.

THE subclavian arteries arise from the arch of the aorta. The left subclavian arises from the extremity of the arch, and just where the aorta is turning down towards the spine. It is longer within the thorax, runs more obliquely to pass out of the chest, receives in a less favourable direction the current of the blood. But the right subclavian arises from the aorta by that artery which is called the ARTERIA INNOMINATA; for it is an artery which can have no name, being neither the carotid nor the subclavian, but a trunk common to both. It is large, rises from the top of the aortic arch, receives the blood in the most direct manner; from which physiologists have deduced those consequences which have been already explained*.

The artery of the arm, as it proceeds, changes its name according to the parts through which it passes. It is named subclavian within the breast, axillary in the arm-pit, brachial as it goes down the arm, and

* Douglas says the left is shorter, which I can by no means understand.

when

when it divides at the bending of the arm, its two branches are named the radial and ulnar arteries, after the radius and ulna, along which they run, until at last they join to form vascular arches in the palm of the hand.

Nature has thus arranged and divided the parts of this artery; and the study of its branches becomes easy to those who will first condescend to observe this simple arrangement and the parts through which it goes. 1st, While the artery is within the breast, it lies transversely across the root of the neck; it supplies the neck, the breast, the shoulder; it gives all its branches upwards into the neck, or downwards into the breast: upwards it gives the vertebral to the inside of the neck (if I may use an expression which cannot now be misunderstood); the cervical, which goes to the outside of the muscles of the neck; the thyroid, which goes to the thyroid gland. While it gives off from its opposite side downwards, and into the chest, the mammary, which goes to the inner surface of the breast; the upper intercostal artery which serves the space betwixt the uppermost ribs; the mediastinum and pericardium; and even the diaphragm, though far distant, receives branches from this mammary artery.

2. When the artery, having turned over the sloping part of the chest, glides into the axilla, and lies deep there betwixt the scapula and the thorax, what parts can it supply, or what vessels can it give off, but scapular and thoracic arteries? Its branches accordingly are three or four slender arteries to the thorax on one hand, named the four thoracic arteries, which give

 twigs

twigs to the glands, the pectoral muscles, and the breast or mamma; and on the other hand it gives off first great articular arteries which surround the joint, and still great scapular arteries which surround the scapula, and nourish all that great mass of flesh which lies upon it.

3. But when this artery takes the name of the humeral artery, and passes along the arm, it must be simple, as the arm is simple; for it consists of a bone of one mass of muscles before and another behind: the artery of course runs along the bone undivided, except that it gives off one branch, which runs parallel along with the main artery, and which running deeper among the flesh, is named muscularis or profunda.

4. It divides at the bend of the arm, in order to pass into the forearm in three great branches. In wounds thus low, all danger of loosing the arm from wounds of the artery, unless by the gross ignorance or fault of the surgeon, is over: we do not attend so much to the parts which it supplies, or, in other words, to its inosculations, as to the parts against which the great branches lie. We observe here, as on all occasions, the. artery seeking protection, and running upon the firmest parts: its three branches now pass; one along the radius, another along the ulna, a third along the interrosseous membrane.

5. In the palm of the hand we find the artery still following the order of the bones; and as the carpal bones are as a center or nucleus, upon which the metacarpal and finger-bones stand like radii, the palmar artery forms a complete arch, from which all the

the fingers are supplied by arteries, issuing in a radiated form.

Of all these subdivisions the subclavian artery is that which seems the least important to know; and yet without a perfect knowledge of it, how shall we understand many important arteries of the neck or shoulder? How shall we understand the anatomy of the greatest of all the nerves, viz. the sympathetic nerve which twists round it? How shall we judge rightly of tumours near it, or of aneurisms which so often mount along this artery from the arch of the aorta until they are felt here?——Of the second division of the artery, viz. where it lies in the axilla, the importance is most unequivocal; since every attempt to stop hæmorrhagies, by compressing this artery, requires a knowledge of it; since every full bleeding wound near this place alarms us, and requires all our knowledge: since every tumour that is to be extirpated opens some of its branches; since we cannot cut off a cancerous breast, or the glands which should be taken along with it, without cutting the thoracic arteries.—Next the artery of the arm, simple as it is, interests us greatly. It is this simple artery which is hurt in aneurisms; it is its delicate, I had almost said capillary, branches, which are to establish a new circulation, and to save the limb. We have indeed no apprehensions of losing the limb for want of blood (the continual success of our operations having established this point); yet it is most interesting to observe the extreme smallness of these branches, as an assurance to us in other cases of danger; though I do indeed believe, that there cannot in any simple wound in any

limb be the smallest danger from this much dreaded obstruction of the blood.

The arteries of the forearm are more interesting still; for if we will be so selfish as to consider the difficulties of the surgeon merely, wounds of the arteries in the forearm are very distressing. These arteries lie deep among the muscles, drive their blood (when wounded) through the whole arm, and either occasion a difficult and most painful dissection, or cause a deep and gangrenous suppuration; so that whether the surgeon be so dexterous as to secure the arteries, or so timid as to leave the arm in this woeful condition, the patient is to undergo such sufferings by pain, or by a long disease, as must interest us greatly.

The arteries even of the wrist and hand, though small, are important. The difficulty of managing wounds of these arteries stands but too often recorded in all kinds of books for us to doubt the fact. If many have died after frequent bleedings from these arteries, though under skilful hands, what ought we not to submit to in the way of study and labour to acquire and to retain a knowledge of these arteries; since by that alone every thing that is surgical in tumours, aneurisms, amputations, is well or ill performed according to our degree of knowledge; and since, according to our degree of knowledge, we are disengaged in our minds, and have free possession of our judgment, to do any thing which may be required? In short, as we proceed along this artery, we shall perceive that each division of it rises in importance; or at least, that if wounds about the axilla be more dangerous, they are proportionably rare; that if

if accidents about the wrist or hand be less dangerous, they are, however, more frequent, so as to deserve every degree of attention.

## I. OF THE SUBCLAVIAN ARTERY.

This artery is so named from its passing under the clavicle by which it is protected; and we include under this division all that part of the artery which lies betwixt the arch of the aorta and the outside of the clavicle, where the artery comes out upon the chest. Here the artery is of a very great size; it lies directly across at the top of the chest, and root of the neck; and like a cylinder or axis, it gives its branches directly upwards and directly downwards to the throat, to the neck, and the parts within the chest. Upwards it sends the vertebral, the thyroid, the cervical, and all the humeral arteries; downwards it sends the upper intercostal artery, and also the internal mammary, which, besides its going along the inner surface of the chest, gives branches to the pericardium, mediastinum, thymus, and other parts.

### 1. ARTERIA MAMMARIA INTERNA.

The internal mammary artery is the first which the subclavian gives off; it is of the size of a crow-quill, long, slender, its ramifications very beautiful. On each side of the chest the mammary artery passes down along all the inner surface of the sternum, and

and ends at the cartilago ensiformis in numerous inosculations with the epigastric artery; for the epigastric arises from the femoral at the groin, just as this does from the subclavian at the top of the chest, and runs upwards along the belly, as this the mammary runs downwards along the breast till they meet each other midway. This is an inosculation, which fifty years ago was much noticed. Physiologists deduced the most important consequences from it, ascribing the connection of the breast and womb to the flux and reflux, to the alternate stoppage and acceleration of the blood in these vessels; although the sympathy of the breasts and womb is plainly a connection which Nature has established upon other laws, upon a kind of sympathy such as we see everywhere in the system, but can in no instance explain.

The course of the mammary artery and the order of its branches, is this: It goes off from the lower and fore part of the axillary artery; it lies on the outside of the membranous bag of the pleura; and considering the pleura as ending in an obtuse and rising apex, the mammary artery lies at first a little behind the pleura, its first movement is to rise and turn with an arch over the top of the pleura or bag which incloses the cavity of the chest; there it descends again, and passes betwixt the ribs and pleura; the artery runs along the inside of the thorax under the middle of the cartilages. At the seventh or eighth rib the mammary itself emerges from the thorax, and becomes an external artery; it first sends a branch towards the ensiform cartilage, which plays round it, and then it goes to the upper part of the abdominal muscles by two

two distinct branches, the one of which is internal the other external. The internal branch goes into the belly or substance of the rectus muscle, descends nearly as far as the navel, and inosculates with the epigastric artery. The external branch turns off to one side, goes rather to the lateral muscles of the abdomen especially to the two oblique muscles, and it inosculates more with the lumber arteries; and so the mammary ends. But as it passes down along the chest, it gives the following branches:

First, Where it is passing the clavicle, bending to go downwards, it gives a small retrograde branch which follows the course of the clavicle, and goes to the muscles and skin of the neck *.

Secondly, It gives an artery, or rather arteries, to the thymus ARTERIÆ THYMICÆ. These are in the adult extremely small, because the gland itself is so; but in the child the gland is large, the upper part lies before the trachea, the lower part lies upon the heart, or rather upon the pericardium betwixt the two lobes of the lungs: the upper end then is supplied by the thyroid arteries; the middle part is often supplied by a distinct and particular branch, viz. by this ARTERIA THYMICA coming from the mammary, but this is far from being always so; the lowest part of the gland has twigs from those arteries which properly belong to the mediastinum, upon which it lies, or to the pericardium, or to the diaphragm.

* Sabbatier is so confused, and copies Haller so ill, that he mistakes this for the transversalis humeri, which is really an important artery.

Thirdly,

Thirdly, The mammary gives also the upper artery of the diaphragm, its lower artery being the first branch of the aorta within the abdomen. This upper artery of the diaphragm is named ARTERIA COMES NERVI PHRENCI, because it accompanies the phrenic nerve. The phrenic nerve is passing from the neck (where it arises) into the chest, by the side of the axillary artery, when it receives from the mammary this small artery which goes along with it; and this artery (which is so extremely small that nothing but its regularity can give it any importance) goes down through the whole chest, accompanying the phrenic nerve over the pericardium till they arrive together on the upper surface of the diaphragm, and spread out there. This artery, small as it is, gives twigs as it passes along to almost all the parts within the chest.

Fourthly, The mammary gives an artery to the pericardium, which may be called the UPPER PERICARDIAC ARTERY; and which is of such importance, that generally when it does not come off from the mammary, it comes from the subclavian itself, or even from the aorta. It belongs to the upper and back part of the pericardium.

Fifthly, The pericardium has another artery from the mammary, which belongs to that part of the heart which is united to the diaphragm: it is thence named by some ARTERIA PHRENICO-PERICARDIACA.

Sixthly, The mammary gives many small arteries to the mediastinum; for the mammary is covered only by the sterno-costalis muscle, which is often hardly visible in Man, so that the artery may be said to lie upon

upon the pleura, betwixt it and the ribs. The mediastinum is just that doubling of the pleura which descends from the sternum to the spine, and of course many small arteries go down from the lower surface of the sternum along the pleura into the mediastinum, and by that to the pericardium, or even to the membrane of the lungs; for the pericardium is one inflection of the pleura and mediastinum, and the covering membrane of the lungs is another.

The mammary, as it goes downwards, sends branches through the interstices of the ribs; two twigs pass through each interstice, going to the intercostal muscles, and to the muscles which lie upon the thorax, as the pectoral muscles; also to the mamma, to the obliquus externus abdominis, and to form loops of inosculations round the ribs with the proper intercostal and thoracic arteries. These twigs pass through the interstices of the six or seven upper ribs, but at the seventh the artery itself comes out. They are too numerous and too small to be either counted or named.

Seventh, The mammary, before it terminates in the two branches, of which one keeps the middle and goes to the rectus muscle, while the other goes outwards to the oblique muscle; as already described, gives about the place of the sixth rib a branch which, in place of passing out of the thorax, keeps to its inner surface, goes downwards along the seventh, eighth, and ninth ribs, makes its inosculations there with the intercostal and other arteries, and ends in the side of the diaphragm, and in the transverse or innermost muscle of the abdomen, which indigitates, as we call it, with the

the diaphragm. From this destination it is sometimes named the RAMUS MUSCULO-PHRENICUS.

### 2. ARTERIA THYROIDEA INFERIOR.

THE LOWER THYROID ARTERY, whose branches go to the neck, the shoulder, and the thyroid gland, arises from the fore part of the subclavian artery, close upon the origin of the internal mammary. It is there covered by the root of the mastoid muscle. It buds out from the root of the great axillary artery, in the form of a short thick stump, which immediately divides whip-like into four small and slender arteries.

1. The main branch of this artery is again named the ramus thyroideus arteriæ thyroideæ. This thyroid artery is the first great branch; it does not ascend directly, but moves a little inwards towards the trachea, from which the root is a good deal removed; it bends behind the carotid artery, is tortuous, ascends by the side of the trachea till it touches the lower lobe of the thyroid gland; it spreads upon it like a hand, inosculates very freely with the upper thyroid artery, and nourishes the gland. This branch moreover gives some twigs upwards to the lower constrictors of the pharynx and to the œsophagus; but its chief arteries, beside those which plunge into the gland, are its TRACHEAL ARTERIES. These tracheal arteries, two or three in number, are reflected along the trachea, turn down with it into the chest, and reach even to the bifurcation of the trachea, where, inosculating with the intercostal arteries, they form a most beautiful net-work.

2. The

2. The ascending thyroid artery, or thyroidea ascendens, is a small and delicate branch, which lies pretty deep, going off rather from the back part of the artery; it supplies all the deep parts of the neck, and even penetrates the vertebræ; it soon divides into an irregular number of branches; the artery keeps almost close to the naked vertebræ lying under most of the muscles; its general tendency is upwards, surrounding the neck in a spiral form. Its chief twigs are, first, some which go towards the surface, *i. e.* to the muscles which lie over the artery, as to the scalenus, the mastoid muscle, the levator scapulæ, and the splenius; and twigs of this artery play over the rectus capitis and the anterior surface of the vertebræ, and attach themselves to the eighth pair of nerves, and to the ganglion of the sympathetic nerve. Its deeper arteries again go to the intertransversarii and other muscles which lie closer upon the neck; and these are the branches which pass in through the intervertebral holes, and penetrating the sheath of the spinal marrow, and following its nerves, inosculate with the spinal arteries.

3. The transverse artery of the neck, or transversalis colli is an artery of the same kind with the last, viz. chiefly destined for the muscles, but more superficial. It passes obliquely round the neck outwards and upwards, goes under the trapezius muscle, and covered by it sends branches as far as the occiput. Its twigs are distributed thus: First to the mastoid muscle and to the skin; next to the trapezius, levator scapulæ, and splenius; then a long branch passing obliquely upwards over the splenius, and under cover

of

of the trapezius, gives twigs to those muscles, and ends in inosculations with the lower branches of the occipital artery; and lastly, another branch goes downwards towards the scapulæ and shoulder.

4. The last branch of this artery is the TRANSVERSALIS HUMERI; an artery so important in its destination, and so irregular in its origin, and so frequently arising as a distinct and particular branch, and having so little relation to these trivial branches of the thyroid artery, that I shall describe it by itself.

### 3. ARTERIA VERTEBRALIS.

THE vertebral artery arises next from the upper part of the subclavian artery; and running upwards and backwards but a little way, it plunges into the hole destined for it in the vertebræ; and it has been already described through all its course both within the bony canal and within the brain.

### 4. ARTERIA CLAVICALIS PROFUNDA.

THE deep cervical artery comes next in order; it is generally the least important of all the branches from the subclavian artery, and the least regular in its place. It often comes from some other branch, and often it is entirely wanting; its course resembles a good deal that of the transversalis colli, *i. e.* it goes to the deepest muscles of the neck, and to the vertebræ, and ends about the occiput; it usually arises from that part of the subclavian artery where it is just going to pass, or has already passed, betwixt the scaleni

scaleni muscles. Its branches are few in number, it gives branches to all the scaleni muscles; others also which play over the anterior surface of the vertebræ and the deep muscles of the neck, as the spinalis colli, intertransversarii, the root of the splenius and trachelo-mastoideus; the complexus also receives a branch which usually inosculates with the occipital artery.

### 5. ARTERIA CERVICALIS SUPERFICIALIS.

THE SUPERFICIAL CERVICAL ARTERY is still less regular, being very often supplied by the thyroid. Its course is directly the reverse of the last, running rather outwards and downwards, or in other words, belonging rather to the shoulder than to the neck. The subclavian artery has got from under the muscles, and has passed the splenii a little way before it gives off this superficial cervical. This artery immediately attaches itself to the plexus of the brachial nerve, and is indeed hidden in the plexus: its first branch is given to the plexus, but its next and chief branch goes across to the top of the shoulder; it sends branches to the levator scapulæ, trapezius, and even to the skin; while a deeper branch goes to the splenius and complexus, where these muscles arise in the neck; and when this artery is large, it sends branches along the margin of the scapula, which go even to the serratus major, rhomboides, latissimus dorsi, &c.

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AFTER enumerating these jarring names, I perceive the necessity of arranging once more those arteries

which go to the neck. Let the student then observe, 1. That the vertebral artery goes to the brain, that the cervical arteries belong to the muscles of the neck. 2. That the thyroid gives two arteries to the neck, the thyroidea ascendens and the transversalis colli. 3. That when a second set of arteries for the neck begins to be enumerated, the name is changed; that of colli is dropped, and that of cervicis adopted. 4. That as there are two branches of the thyroid going to the neck, viz. the ascending thyroid and the transversalis colli, there are also two entire arteries going to the neck, and which come off immediately after the thyroid, viz. the cervicalis profunda more constant, and the cervicalis superficialis which is less regular.

### 6. ARTERIA INTERCOSTALIS SUPERIOR.

The upper intercostal is given to supply the intercostal space betwixt the two uppermost ribs, because the aorta which give out all the other intercostalis, regularly one for each rib, does not begin to give them off till after it has made its turn downwards; of course it leaves the two upper ribs without arteries. To supply this, then, is the office of the superior intercostal artery, which is about the size of a crow-quill, and goes off from the subclavian generally next after the vertebral and thyroid arteries. It comes from the upper and back surface of the subclavian trunk; it turns downwards and backwards and lodges itself by the side of the spine in the hollow where the spine and the first rib are joined, and where the first thoracic

thoracic ganglion of the great intercostal nerve lies. Before it takes its place betwixt the ribs as the intercostal of the two upper spaces, it sends a branch upwards upon the face of the lower vertebræ of the neck, which is given to the scaleni, to the longus colli muscle, and to the nerves; next it gives off the highest intercostal artery for the space betwixt the first and second ribs, which artery divides into two branches; one perforates the thorax, and goes out upon the back, and supplies the muscles which lie flat upon the back of the chest; while another branch, the proper intercostal branch, runs along betwixt the ribs.

Next it gives eff a second intercostal artery, which also has its external and internal branches, and of which a branch inosculates over the third rib with the uppermost intercostal of the aorta. Besides these, it gives also small branches to the œsophagus, which inosculate with the tracheal arteries; and it gives branches to the spinal marrow, which pass into the canal along the holes for the nerves; and which not only supply the sheath, but also inosculate with the arteries of the spinal marrow itself.

### 7. ARTERIA SUPRA-SCAPULARIS.

THE SUPRA-SCAPULAR ARTERY, or the superior scapular artery, is one of such magnitude, is so different in size and destination from the cervical and other small arteries of the neck, that it ought to be described apart; though of great size and importance, it is yet so little known, that Sabbatier does not even describe nor name it.

The SUPRA-SCAPULAR ARTERY very often comes off from the THYROID artery; in which case it is the last in order of all the branches of the thyroid, that is to say, the nearest to the shoulder, and then it is named TRANSVERSALIS HUMERI, because of its going across the root of the neck to the shoulder. Sometimes it arises from the cervicalis superficialis; but then it is a small artery, and I suspect it reaches in such cases no further than the tip of the shoulder, and does not descend to the scapula. Often I see it arising as a distinct artery, large, very long, tortuous like the splenic artery, and almost equalling it in size; running across the root of the neck, till at the top of the shoulder it dives under the acromion process; and then passing through the notch of the scapula, supplies all the flesh of its upper surface.

The reason of my naming it supra-scapular artery, is its passing thus over the scapula, while another, the largest branch of all those proceeding from the subclavian artery, is named subscapularis, from passing under the scapula.

To repeat the origin then of this supra-scapular artery, it arises sometimes as an independant artery, and is so great, that we wonder that it does not always do so: often it arises from the thyroid, is its last branch, and is named TRANSVERSALIS HUMERI, authors not observing that it belongs absolutely to the scapula; it rarely arises from the cervicalis superficialis; and when it does so, it is small: often in a strong man it arises apart; and when it does arise from the thyroid or cervical arteries, it is so large as

to annihilate as it were all the other branches of the artery from which it arises.

Where this artery passes out of the chest it is covered only by the root of the mastoid muscle; and it gives twigs to the mastoid, to the muscles which ascend to the throat, to the subclavian muscle, to the fat, jugular vein, and skin.

Next it gives a superficial branch to the skin, trapezius, and other superficial parts about the shoulder.

Next it turns over the acromion process, passes through the suprascapular notch, with many windings and contortions; spreads itself over all the outer surface of the scapula, both above and below the spine, and is the sole suprascapular artery. The manner of its spreading is this; having passed through its hole in company with the suprascapular nerve, the instant that it has passed the hole and begins to lie flat upon the scapula, it sends off two branches, one on either hand at right angles; and of these one goes along the upper border of the scapula towards its basis, the other goes in the other direction towards the shoulder-joint, and circles round the upper side of the spine or ridge of the scapula.

The main artery having first perforated the scapular notch, and given these two small branches, next makes a second perforation, viz. by passing under the root of the acromion process; and then it again divides into large branches, in which it ends. The one branch runs all along the root or base of the spine or high ridge; the other branch runs nearly in the same direction, but lower down, viz. nearer that edge

 where

where the great subscapular artery runs; and with which, of course, it makes many free inosculations.

This artery lies so across the neck that it may be cut, especially in wounds with the sabre; and in a big man it is such size as to pour out a great quantity of blood. It is necessary for the surgeon to remenber the great size of this suprascapular artery, its long course over the shoulder, at what place it arises within the chest, and how it may be compressed. But in another aense also it is peculiarly important; for the suprascapular artery makes inosculation with the lower scapular artery, freer, and fuller than in almost any other part of any limb. One can hardly force tepid water through those small arteries which support the arm after the operation for aneurism; but the inosculations of this suprascapular artery are so free, that often, though I have tied the arteries with great care, the very coarsest injection has gone round by it; and when I desired only to inject the head, I have found the arteries of the arm entirely filled. The conclusion which this leads to in wounds of the axillary artery is too obvious to need any further explanation.

## II. OF THE AXILLARY ARTERY.

This artery assumes the name of axillary, where it lies in the armpit or axilla. The scaleni muscles being attached to the ribs, the artery passes first through betwixt the first and second scalenus; next it passes out from under the arch of the clavicle, where it was protected;

protected; then it falls over the breast in a very oblique direction; it inclines outwards towards the axilla, lies flat upon the slanting convexity of the chest, is covered by the pectoral muscles, because the pectoral muscles arise from the clavicle, under which the artery passes; but far from being protected, it is so far exposed as to be easily felt beating, and it is at this point only that it can be rightly compressed. It declines still outwards and downwards, till at last it gets so deep into the arm-pit, and so much under the scapula, as to lie betwixt the serratus anticus and subscapular muscles. There it is rightly called the axillary artery In this hollow it lies safe, protected by the deep borders of the pectoral muscle before, and of the latissimus dorsi behind, surrounded with fat and glands, inclosed within the meshes of the plexus, or great conjunction of nerves, which go to the arm, surrounded also by all the veins of the arm, which twine round it in a wonderful manner. Here it gives off the thoracic arteries to the thorax, and the scapular arteries to the shoulder. In short, the axilla itself is a complicated study; but in all that respects the arteries it may be made very easy and plain. But let the surgeon remember that it is only by a perfect knowledge of the arteries, a bold stroke of the knife, and a masterly use of the needle, that the patient is to be saved from bleedings after wounds hereabouts! for the old story of compressing the axillary artery above the clavicle is now of no credit with any surgeon of knowledge or good sense.

As the artery turns over the borders of the chest, it gives one or two twigs to the adjacent parts,

 as

as to the scaleni, and to the great nerves which lie over the artery, and to the serrated muscle, where it lies under the scapula: but these branches are so small that it is unnecessary either to number or describe them. The thoracic or external mammary arteries are the first important branches; they are four in number, and they are named after their place or office.

### 1. ARTERIA THORACICA SUPERIOR.

THE UPPER THORACIC ARTERY, being the first, lies of course deep in the axilla. It comes off about the place of the first or second rib; it lies betwixt the lesser pectoral and the great serrated muscles; it gives its chief branches to these muscles, and it also gives other branches to the intercostal muscles and the spaces betwixt the ribs. But, upon the whole, it lies very deep, is small, is so short that the next is entitled thoracica longior; it is an artery of little note.

### 2. ARTERIA THORACICA LONGIOR.

THE LONG THORACIC ARTERY is more important, supplying all the great pectoral muscles and the mamma. It was named the external mammary artery; but we are the more willing to change the name, since it has no likeness to the internal mammary artery; is in no respect a counter-part to it; it might be named the pectoral artery. It is long, not tortuous, but straight and slender, and about the size of a crow-quill. It is needless to describe an artery so variable in its

branches as this is; it is sufficient to say, that after giving small twigs to the axillary glands, it terminates with all its larger branches in the pectoral muscle, mamma, and skin, and in inosculations with the intercostals and internal mammary; it is very long, descending sometimes so low as to give branches to the oblique muscles of the belly.

### 3. ARTERIA THORACICA HUMERARIA.

THE THORACIC ARTERY of the SHOULDER goes off from the upper and fore part of the axillary artery. Its place is exactly opposite to that of the mammaria superior, viz. under the point of the coracoid process, insomuch that Haller has named it thoracica acromialis. It is a short, thick artery; it bursts through the interstice between the pectoral and deltoid muscles, and appears upon the shoulder almost as soon as it comes off from the main artery; it resembles the thyroid in shape, being a short thick artery, terminating all at once in a lash of slender branches, which go over the shoulder in various directions: but I never could observe any order worth describing. One deeper branch goes to the serratus major, a branch goes along the clavicle, gives it the nutritious artery, and then goes on to the pectoral muscle, and to the skin of the breast: it gives small branches to the axillary glands, and larger ones to the deltoid and pectoral muscles and skin of the shoulder, for this is very much a cutaneous artery. The chief branch is that which is last named, running down betwixt the deltoid

and

and pectoral muscles; and the most curious branch is a small artery which accompanies the cephalic vein, and runs backwards along the course of the vein, a small and beautiful branch.

### 4. ARTERIA THORACICA ALARIS.

SOMETIMES, though not always, there is a fourth thoracic artery. When it exists, we find it close by the last artery; its branches, which are sometimes numerous, belong entirely to the cup or hollow of the axilla; it goes to the glands and fat, and thence its name of ALARIS OR AXILLARIS. This is the deepest or backmost of these mammary arteries; it attaches itself to the lower border of the scapula, and we often see it running along the lower border a considerable length, and giving branches chiefly to the subscapularis muscle.

THESE are the four mammary arteries which go to the breast. The arteries which go to the scapula follow next, and are only three in number; one, which is the counterpart of the suprascapular artery, is the greatest branch from the axillary artery, supplies the lower surface of the scapula, and thence is named SUBSCAPULAR ARTERY; one, which, as it is reflected round the joint by the outside, is named the EXTERNAL CIRCUMFLEX ARTERY; and one, which, as it turns round the inner side of the joint, is named the INTERNAL CIRCUMFLEX ARTERY.

5. ARTERIA

### 5. ARTERIA SUB-SCAPULARIS.

THE SUBSCAPULAR ARTERY is of a great size; it is hardly described in books, I might say is hardly known to anatomists. Douglas, and most especially Sabbatier, have scarcely named it, though it is in fact one of the largest arteries in the body, being absolutely as large as the axillary artery, from which it takes its rise*.

The greatest mass of flesh in almost any part of the body is that which lies under and around the scapula in a strong man; and this artery supplies almost all that mass. It goes off from the axillary opposite to the neck of the scapula, just under the long head of the biceps brachii: it no sooner comes off from the axillary artery, than it attaches itself to the lower border of the scapula; and as soon as it comes to the edge of the scapula (but sometimes lower down the edge, viz. where the head of the biceps comes off) it splits into two great branches; one of which goes to the upper, and one to the lower surface. But to describe each little artery among such a mass of flesh, or to expect to find them regular would be very thoughtless; the general course of them only can be described. First, The greater branch which goes to the lower surface of the scapula, is the proper trunk of the subscapular artery;

* It is named often scapularis inferior or infra-scapularis; it is better named subscapular, both to harmonize with the name subscapular muscle, to which it belongs; and also to contrast with its counterpart, the suprascapular artery, which comes from the subclavian artery.

artery; it divides into two great branches, which course all over the lower or hollow surface of the scapula: one of these is deeper, runs downwards along the naked border of the scapula, lies under the muscles upon the flat bone, and supplies the inner surface of the subscapular muscle with many branches. It sends a branch upwards, which runs along the inner surface of the neck of the scapula, runs still forwards under the root of the caracoid process, and its extreme branch goes round by the basis of the scapula to make an inosculation with the larger branch.

Secondly, The larger branch keeps nearer the surface, and supplies all the outer side of the subscapular muscle. Its general course is round the scapula. down the fore edge, then round by the lower angle, then up by the line of the basis scapulæ, encircling it with what might be named a coronary artery. It first gives branches to the teres major; then passes down along that muscle to the angle of the scapula; then turning along the angle of the scapula (which it does not do without leaving many branches behind), it runs in a waving line all round the basis scapulæ, till it arrives at the upper corner, where it ends in free inosculations, both with its own deeper branch, and also with the suprascapular artery which comes along the shoulder.

Now this great branch, with all its arteries, belongs entirely to the lower surface of the scapula; but the branch which leaves it at the neck of the scapula turns round under its lower edge, gets to the upper surface of the scapula, runs in under the infra-

spinatus

spinatus and teres major muscles, betwixt them and the bone; and although the suprascapular artery from the shoulder supplies chiefly the upper part of the scapula, yet it is chiefly above the spine that that artery circulates, while the lower parts of the Infra-spinatus and the Teres minor muscles are left to be supplied by this reflected branch of the subscapular artery: thus this reflected branch gives its arteries, first to the Teres, then it enters into the hollow under the spine, and besides supplying the infra-spinatus and the bone itself, it also makes a circle, though a shorter one, and inosculates with the supra-scapularis, just as the other branch of this same artery does on its lower surface. This branch descends nearly to the corner of the scapula before it begins this inosculating circle; but it sends also another chief branch round the neck of the scapula, which advancing towards the suprascapular notch, inosculates very largely with the suprascapular artery.

Thus is the scapula encircled, and supplied with a wondeaful profusion of blood by two great arteries; one, the SUPRASCAPULAR ARTERY, coming across the neck, over the shoulder, and through the scapular notch; another, the SUBSCAPULAR ARTERY, which comes from the axilla to the lower flat surface of the scapula, and divides at the edge of the scapula into two great branches; one of which keeps still to the flat surface, while the other turns over the edge of the scapula, and supplies in part its upper or outer surface.

6. ARTERIA

## 6. ARTERIA CIRCUMFLEXA POSTERIOR.

THE POSTERIOR CIRCUMFLEX ARTERY is a very large one. It arises either along with, or immediately after, the great subscapular artery; the place of it is of course settled by the place of the shoulder-joint, for it belongs so peculiarly to it that it is sometimes named the Humeralis, sometimes the Articularis, sometimes the Reflexa Humeri. It goes off between the subscapularis and teres major muscles; it passes in between them to get to the joint; it then turns round the shoulder-bone, accompanied by the circumflex nerves, just as the suprascapular artery is accompanied by the suprascapular nerve; it ends, after having made nearly a perfect circle, upon the inner surface of the deltoid muscle.

Its branches are, first, Twigs to the nerve which accompanies it, and to the capsule of the shoulder-joint.—Secondly, Branches to the coraco-brachialis and short head of the biceps, and to the triceps, and a twig to that groove in which the tendon of the long head of the biceps lies.—Thirdly, It sends large branches to the subscapularis, to the long head of the triceps, &c.—And, lastly, The artery, far from being exhausted by these branches, goes round the bone, turns over the joint under the deltoid muscle, and ends in a great number of branches, still accompanied by branches of the nerve, which are distributed in part to the capsule, but chiefly to the lower surface of the deltoid muscle, where it lies upon the joint.

7. ARTERIA

### 7. ARTERIA CIRCUMFLEXA ANTERIOR.

The anterior circumflex artery, which goes round the fore part of the joint, bears no kind of proportion to that great artery which passes round the back. The anterior goes off from the same point nearly with the posterior, or sometimes arises from the posterior itself; it takes a direction exactly opposite; it keeps close to the shoulder-bone, passes under the heads of the coraco-brachialis and biceps; encircles the head of the os humeri just at the root of the capsular ligament, and goes round till it meets and inosculates with the posterior circumflex artery. I never could find those muscular branches which are said to go to the scapula, or have found them very trivial; the whole artery belongs to the bone and its parts; it encircles the root of the scapsule with a sort of coronary artery; it gives twigs to the capsule, the periosteum and the tendons, which are implanted into the head of the bone; and having given twigs to the heads of the biceps and coraco-brachialis, it gives off its only remarkable branch, which is indeed regular and curious; it is a small branch which runs down along the bone in the groove in which the tendon of the biceps lies.

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Concerning the axillary artery in general, there is more to be observed than this occasion will allow. But

But these things must not be passed over in total silence. In the first place, the artery, as it passes over the border of the chest, and after leaving the arch of the clavicle, is felt beating, and there only can it be compressed.

The compressing of the subclavian artery with a tourniquet or with the thumb, attracted at one time so much attention, and incited so many to speak about it, that it came to be thought important, and has been ever since esteemed practicable; and yet even those who have spoken the most confidently have taken the thing merely upon vague report, have neglected to read the proper books, have described the way of compressing as above the clavicle, not knowing that it should be done below it, Camper, in his "Fabrica Brachii Humani," first mentioned what he had demonstrated in his class, viz. that it could, by placing the thumb under the point of the carocoid process, so compress the axillary artery against the second rib where it lies upon it, that even the strength of a syringe could not push an injection through it *. And those who

* In cadaveribus plus semel in publico threatro monstravi, comprimi posse integram arteriam; ligabam arteriam aortam infra arcum, resecabam deinde axillarem dextram, ac siphone axillarii sinistræ adaptata fortiter aquam impellens, solo digito eo modo moderare potui subclaviam, ut ne gutta quidem efflueret: quod quanti momenti esse queat in amputatione humeri in articulo nemo non videt. In vulneribus sclopetariis, aliisque circa humeri articulum inflictis, sanguinis profusionem similiter compescere, si non penitus sistere possemus. Vid. *Camper*, lib. i. p. 15.—The plain reason why we are able thus to

who learn things by hearsay, have said that "the subclavian artery could be compressed by thrusting the thumb in above the clavicle;" although, in fact, the arch is so deep, the muscles so strong, and the artery so little exposed, that this is absolutely impossible.

From my speaking with a seeming interest about the preference of one of these two places to the other, it may be thought that I believe this piece of knowledge useful: Quite the reverse! I know it to be dangerous; I know it to be less practicable than authors report and believe; and I repeat what I said on a former occasion, that "it is easy to stop the pulse of an artery, but quite another matter to stop the flow of blood through it." We thrust down our hands and compresses, and rest with our whole weight upon the artery; it seems stopped, because the pulse is stopped; but the first stroke of the knife shows us how far we are gone in a dangerous mistake. I may say, without breach of confidence, that I have seen one gentleman trust to it, who will never trouble himself about it again. He was a dexterous surgeon; and in a great aneurism of the axilla was deluged with blood at the first stroke of the knife, and saved his patient only by a plunge of the great needle.

Secondly, It is much to be lamented that we cannot really suppress the blood; not merely because it

to compress the artery in the dead subject is the want of resistance in all the muscles. If ever it be possible in the living body, it must be when the strength is low, and the circulation very languid, after the patient has fainted with loss of blood.

would make every wound less dangerous, but because it would greatly facilitate operations which we are called upon every day to perform. Would it not be pleasant if we could cut the cancerous breast without the loss of blood? or search into the axilla with perfect deliberation, and cut diseased parts out with the knife, not tearing them in a brutal manner with our fingers? Yet still, by studying this piece of anatomy, the surgeon knows both from what source all the arteries which bleed upon the surface of the amputated breast come, viz. the long mammary artery; and also that in any very dangerous situation it would be easy to command all the bleeding orificies by one dip of the needle, the axilla being open. He also knows that the thoracica alaris and the short thoracic artery supply all the glands, and that these lurk too deep in the axilla to be secured otherwise than by a compress: so that these arteries are in fact opened by tearing with the fingers, and are stopped by thrusting in a spunge. He knows also how many large arteries there are, especially about the scapula, of which the bleeding must resemble that of the axillary artery itself; he will judge of the nature of the wound by the pulse; and he will act with great advantage in all doubtful cases, by remembering these great arteries of the scapula, which either bleed outwardly most furiously, or if they seem to stop, it is only by filling the axilla with blood.

Thirdly, The connection of the artery with the axillary nerves, though it must be more fully described in another place, must yet be observed here as a relation too important to be omitted. The artery

passes

passes along with the nerves through the insterstice of the scaleni muscles; the nerves, which consist of no less than seven pairs, make by their mutual connections a sort of net, which is called the plexus of the axillary nerves. This plexus has its meshes formed, not by small divisions, but chiefly by the seven great cords. This broad plexus lies over the artery as it comes out from the chest; the artery perforates the plexus, or passes through one of the largest meshes in the cavity of the axilla; and when we extend the arm, for example, to cut out an axillary gland, the great veins lie nearest the knife, or lowest in the axilla; the plexus of nerves next; and last of all the artery which has just perforated the plexus of these great nervous cords; three nerves are below the artery and two above; and when the arm is luxated, and the shoulder-bone pushed downwards, the head of it is so pressed against the net of nerves, and the artery is so compressed betwixt the head of the bone and the mesh of nerves, that I have very seldom failed to find the pulse almost entirely suppressed in luxations of this kind.

This connection, viz. with the nerves, is a very interesting one. It is plainly such that the artery cannot be hurt without a wound of the nerves; it has never been known that the artery has been cut in the axilla without the arm being lamed by this wound of the nerves: also the nerves cannot be hurt without the artery being in danger; but it does escape sometimes; of which, among other examples, this is one of the most singular.—I have seen the artery escape in wounds when the nerves were hurt; but how it could escape

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the stroke of a blockhead's needle in the following case, I am at a loss to conceive. A Woman came to me with a great string hanging in her axilla, and along with her came her surgeon. He had about three months before cut off her breast for a cancer, and moreover some glands from the axilla, from which there was a bleeding; and of course, as his fingers could not go deep enough, he took a needle proportionably large, struck it down into the arm-pit, and tied all up. When he brought his patient to me, there hung from the arm-pit, not a surgical ligature, but a good large tape; the axilla was a large gaping and terribly fetid ulcer; I passed my finger into it, and felt the arteries beating around it, and the tape firm about some cord of nerves, whether one or more I could not tell; the Woman's fingers were as crooked as a bird's talon, and her arm hung by her side quite useless and lame. I made the surgeon feel the nerve with his finger, and offered to cut out the ligature safely; but he carried away his patient, that he might, though at a long interval, finish the operation himself.

The breast had been long healed, and the cord acted as an issue in the axilla. How near the edges of this needle must have been to the great artery, it is terrible to think; and it is most providential that such accidents do not happen daily, considering how much this crooked needle is used in deep places, where it is least fit to be used.

III. OF

## III. OF THE BRACHIAL ARTERY.

The brachial artery is that division of the artery which is marked by the tendon of the great pectoral muscle; for as that is the fore border of the axilla, all above that is axillary, and all below it brachial artery, down to the bend of the arm, where it divides into the radial and ulnar arteries. The brachial artery runs close along the os humeri on its inner side, here the bone is most naked; and this is the line in which we feel the artery beating, and apply the cushion of the tourniquet.

To describe, as some authors have done, each insignificant and nameless branch which this artery gives off, were to make a simple matter intricate beyond all enduring. The whole matter is this: As the artery goes downwards, lying exactly on the inner side of the arm bone, and directly in the middle betwixt the biceps on the fore part and the triceps behind, it gives frequent branches to each. Those going to the biceps are short, small, pretty regular, and exceedingly like each other all the way down the arm; and they are thus frequent, and very short, in consequence of the artery adhering closer to the sides of the biceps. Not one of them can be distinguished, or is worth naming. Those which it sends downwards to the triceps are (in consequence of that being a large muscle, with several thick and fleshy origins) both longer and more tortuous, and more important; and they accordingly

have some of them appropriated names. Of these arteries going down towards the back part of the arm, and working their way among the muscles, three chiefly are to be observed. First, The arteria profunda superior, which goes round the back of the arm to the exterior muscles, and is often named the upper muscular artery. Secondly, Another like it, called arteria profunda inferior, or the lower muscular artery. Thirdly, The ramus anastomoticus major, which anastomoses round the elbow with the branches of the ulnar artery. These three chiefly deserve notice.

### 1. ARTERIA PROFUNDA HUMERI SUPERIOR.

THOSE arteries, which in the limbs go deep among the fleshy parts, as in the arm or thigh, have always one of two names, either profunda or muscularis, and often both. The upper deep muscular artery of the arm is about the size of a crow-quill, or larger; it goes off from the inner side of the brachial artery, just where the tendons of the latissimus dorsi and teres are inserted, and very often it arises from the great artery of the scapula, or that of the joint, viz. the sub-scapularis, or reflexa humeri.

The PROFUNDA turns downwards and backwards round the bone; it glides in betwixt the first and second head of the triceps; there it divides within the thick flesh of that muscle into two chief branches, or the two branches sometimes part immediately after their common origin, or sometimes they go off apart

from

from the humeral artery. One of these, perforating the biceps muscle, turns quite round the bone; and Monro the Father, who gave us the name of spiral nerve, named this also, very properly, the muscular spiral artery: so this artery also, as well as the supra-scapular and circumflex arteries, has its accompanying nerve. This long artery runs down the back and outside of the arm; it descends quite to the outer condyle of the os humeri, and by branches round the olecranon, and over the outer condyle, it inosculates very freely with the radial artery.

The other branch of the profunda superior runs down the inner side of the arm, gives many branches to the triceps, and coraco-brachialis; gives a few also to the biceps and deltoid muscle: its longest branch, the proper termination of the artery, runs downwards till it touches the inner condyle, as the posterior branch does the outer condyle; and this inner artery communicates with the outer branch round the olecranon, making small but frequent and beautiful inosculations; and it also inosculates over the condyle with the reflected branch of the ulnar artery. In short, the profunda superior turns down towards the back part of the arm, buries itself under the triceps muscle, supplies all the flesh of the triceps, and divides in the heart of that muscle into two branches, both of which go down to the elbow-joint, and inosculate; the one, round the outer condyle with the radial artery; the other, round the inner condyle with the ulnar artery.

## 2. ARTERIA PROFUNDA HUMERI INFERIOR VEL MINOR.

THE LESSER PROFUNDA, or the lower muscular artery, is so named because it resembles the former in almost all points. It is smaller, being not half the size (viz. of a crow-quill), and goes off, in general, about two inches lower down the arm. Its course, also, is exactly similar, except in this, that it is single, does not divide into two branches; it gives twigs to the muscles of the arm; runs down to the inner condyle, and after touching it, makes a sudden and serpentine turn, by which it gets upon the back part of the elbow-joint. Its chief inosculations are with the upper profunda, and with the recurrens interossea upon the back part of the joint.

Betwixt the upper and lower profunda there generally is sent off that artery which is to nourish the bone. It is named ARTERIA NUTRITIA HUMERI; but is not of sufficient importance to be numbered among the main branches of the artery. The nutritious artery sends off small branches, or rather small twigs, to the brachialis, or that muscle which lies under the biceps and to the triceps; and it perforates the bone about its middle in one larger artery, and sometimes there are also one or two smaller ones.

## 3. RAMUS ANASTOMOTICUS MAJOR.

THE GREATER ANASTOMOSING ARTERY is one of three or four which anastomose round the elbow-joint:

joint: for as the humeral artery advances towards the bend of the arm, it begins about three inches above it, to give off sidewise, and almost at right angles with the trunk, three or four small arteries, more or fewer, according to the size of the arm. Each of these sends its little twigs round the condyle, to inosculate with the arteries of the forearm both radial and ulnar. Among these one is distinguished for its size and importance; it is one of the largest of these arteries, and thence named ANASTOMOTICUS MAGNUS; it arises from the Humeral artery about three inches above the joint; it lies close by the side of the brachialis internus, and gives many branches to it and to the triceps; but it is chiefly expended in three branches, one of which turns backwards, and running up the arm gives branches to the muscles, and inosculates with the profunda: another goes downwards towards the middle of the bend of the arm, and gives branches to the pronator teres and the flexor digitorum; and then going deeper, it touches the capsule, and makes a beautiful inosculation over the forepart of the joint with the radial recurrent or inosculating artery: another branch, the most important, and the chief termination of the artery, runs down betwixt the olecranon and the condyle, in the hollow where the ulnar nerve lies. It first contributes to that net-work of inosculations which covers the back of the joint over the olecranon; it inosculates very freely with the recurrens ulnaris; and it is this inosculation that gives the artery its importance and its name. This is the channel through which the blood goes after the operation for the anuerism, as we know from preparations; and I have several times

times felt for it, and found it after the operation, while the arm was still very small, having been wasted by the disease and by the suppuration.

I have not, in describing these arteries of the arm, once mentioned the name of collateral artery; for it is a name which must be entirely dropped, because it has been much abused. Sabbatier, Murray, Haller, and all the French and German anatomists, have named the arteriæ profundæ COLLATERAL ARTERIES; because they lie alongside of the great artery, running along with it down the arm. Douglas, and the English anatomists and surgeons, have called the three or four short anastomosing branches near the elbow the collateral arteries; because, though they run off at right angles or obliquely from the trunk, yet they run parallel with each other. Dropping this name, then, we find no more than three arteries in the arm of any note: the upper or greater profunda, with its two branches; the lower or lesser profunda; and the great anastomosing artery.

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## OF THE ARTERIES OF THE FOREARM, VIZ. OF THE RADIAL, ULNAR, AND INTEROSSEOUS ARTERY.

THE place and condition of this artery at the bend of the arm is as interesting as where it lies in the axilla; for while bleeding is allowed, or is practised by low and ignorant people, operations at this point must be more frequent than at any other, and must be easy or successful only in proportion as the artery and all its relations is well understood.

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The humeral artery still continues an undivided trunk, much lower than the bend of the arm; though we are accustomed to name that as the place at which it divides. The whole arm, it must be remembered, is covered with a fascia, and that fascia lies over the artery; but at the bend of the arm there is a peculiar fascia, or at least the round tendon of the biceps so strengthens the general fascia, by sending a broad expansion obliquely across the bend of the arm (which fascia is fixed into the condyle and down the edge of the ulna), that we call this expansion peculiarly the tendon of the biceps, and say that the artery is at the bend of the arm covered and protected by the tendon of the biceps muscle. The condition then of the artery is shortly this: It comes from the inside of the arm, inclining all along towards the middle of the bend or folding of the forearm; there, without any particular ring or aperture for its admission, it passes under the aponeurosis of the biceps muscle; for the aponeurosis of the biceps and of the arm in general are one continued sheath. When thus lodged behind the tendon, it lies in a deep hollow betwixt the flexors and extensors of the arm, or, in other words, betwixt the muscles of the upper and of the lower edge; the tendon of the biceps covers this triangular hollow; the floor or bottom of it is the coronary process of the ulna and the forepart of the elbow-joint, and there the artery lies imbedded in cellular substance, encircled by those veins which accompany the artery particularly, and which are thence named venæ comites; and it carries along with it a nerve in diameter equal to itself, and this nerve is named the great radial nerve.

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The artery does not divide immediately even after it has thus passed the bend of the arm, but goes down deep among the flesh of the forearm, and there divides; the ulnar artery being lodged under the thick flesh of the pronator and flexor sublimis muscles, and the radial artery under the strong fleshy belly of the flexor radialis and of the supinators, not absolutely within their substance, but under cover of their fleshy bellies, which swell out into a great thickness at this part of the arm. The only part of the artery which is exposed, the point which we feel beating is that where the single and undivided trunk first begins to pass under the thicker fascia of the biceps muscle; and there the artery is pushed forwards, raised, and made to appear superficial by the projection of the coronoid process and brachialis muscle, or, properly speaking, by the protrusion of the forepart of the elbow-joint. This is just before it sinks into the triangular hollow betwixt the muscles.

This artery is singular in one kind of lusus naturæ, which never happens, nor any thing similar to it, in the lower extremity, viz. that the trunk of the artery forks into two great branches high in the arm; sometimes in the axilla, but oftener in the middle of the arm, or opposite to the pectoral muscle: and I have constantly observed, when this happened, that the radial artery was, as it were, the accidental branch, and passed across the arm near the bend of the elbow, so as to traverse the ulnar or main artery; and that the radial artery passes quite on the outside of the fascia, which binds down the ulnar or main branch of the artery.

This

This short description involves many points which the surgeon should think of, and more than can be touched upon in this place. The following consequences certainly follow from this arrangement of parts.

First, The artery lying thus deep under the biceps, cannot be hurt by any skilful surgeon, though bleeding the very vein under which it beats, and at the most critical point; it is hurt, as far as I have observed, only by the rudest stroke of very ignorant fellows; I have seen in six cases a wound in it little less than a quarter of an inch in length. In one of the operations I found it absolutely transfixed; the blood had been poured out from the orifice behind; I felt with surprise the artery running over the tumor, not under it; and having opened the sac, I passed a probe through the artery from side to side.

Secondly, Since the artery divides only after it has gone deep, where its great branches are protected by the muscles of the forearm, the trunk only is wounded in bleeding; the branch is never wounded; and we cannot but be surprised that Hunter, Haller, Sharp, and others, who ought to have studied this point, believed it to be sometimes at least wounded in one of its branches; nor can we think, without surprise, of the arteries being so little understood in the time of Dr. Monro the Father, that he is forced to argue the propriety of doing the operation of aneurism from this fact, "That though it were dangerous to trust to the common anastomosis round the elbow, yet it sometimes happens, that the two branches of the radial

dial and ulnar are set of in the axilla." This surely must have been but a cold assurance to the surgeon in those days, viz. that he was to trust chiefly to the chance of a lusus naturæ for the success of one of his greatest operations.

Thirdly, It must follow, since the artery lies behind the fascia, and is wounded through it, that the blood being poured out behind the fascia, must raise it into a hard, firm, and (in time) inelastic tumour, growing every day firmer and harder. If surgeons will but think of this, they will go through their operation more correctly. It makes a point of vast importance in the description of aneurism, since it gives outwardly the true character, and inwardly the true shape and appearance of the tumour, when the operation is begun, the outward incision being performed. Had it been but attended to rightly, what noise and wrangling might it not have saved about the nature and names of the disease (yet still the older surgeons knew and described this piece of anatomy, though they made but a poor use of it)? and what idle and stupid descriptions might it not have prevented, such as we have never seen in surgical books till now, of diffused aneurism, and the operation for diffused aneurism; when in truth the first stroke of the knife shows it to be a tumour very different from that which such names, and such formal divisions, and old fashioned descriptions must convey? The cup of an aneurism is the triangular hollow which I have described, and the bag of the tumour is the extended fascia.

Fourthly,

Fourthly, The course of this double artery tempts me to believe, that in those few cases where the blood of an aneurism was truly diffused, where it was an ecchymosis, where the blood was not confined by the fascia, but poured out under the skin, and driven upwards to the shoulder, and downwards to the fingers, giving the whole arm the appearance of mortification; that in such rare cases, there must have been a high division, and that the preternatural artery had been wounded, for it lies above the fascia, it is lodged in no hollow, such as might receive its blood, nor covered by any membrane which might confine it; but at all events, I am persuaded that Hunter is wrong in suspecting that, since the pulse so seldom returns instantly, this preternatural artery and the true one must be often tied together; for if the preternatural artery were wounded, it would be a very diffused aneurism, under the skin and above the fascia; but the main artery would be found in its place, under the fascia, quite safe; whereas, if the true artery were wounded, the tumour would be under the true fascia, the preternatural artery would cross by the side of the tumour, or over it, and the wounded artery being at the bottom of its own tumour, the two arteries would be six inches apart. Besides, the necessity of supposing this is not so strong as Hunter believed; I have seen the pulse return during the dressing of the arm, when the dissection was so wide and free that I am sure there could be no lusus naturæ, but one artery dividing in the common place.

Fifthly, The close connection of the artery with the great radial nerve must always be considered in all

all wounds at the bend of the arm; and especially it constitutes a difficulty in the operation of aneurism, of which authors of great eminence have spoken far too lightly; and surgeons of character have tied it in with their great ligatures, as if for amusement, or that they might see what would ensue. But, as I have said on another occasion, "a man must show me either some positive necessity for doing this, or some positive good consequences which will result from it, before I admit him to argue about the bad effects which may ensue." Will any man persuade me, after the case which I have just related, that it is good or harmless to tie in the largest nerve of the arm? We see by that case, that the ligature's remaining firm in its place for three months is one of the least of the ill consequences, and the others may easily be conceived. Of these ill consequences I have seen more than I will venture to tell.

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The humeral artery having left this most critical point at the bending of the arm, divides into three great branches, the radial, ulnar, and interosseous arteries; at least the ulnar gives off the interosseous so soon, and the interosseous is so large, and has so pointed a destination, that I take the privilege of describing the three branches apart. The ULNAR ARTERY, which we must regard as the continuation of the main artery, makes its way through the thickest flesh of the forearm, goes along the ulnar edge of the arm, appears again from under the flesh, about three or four inches above the wrist; it goes down to the root of the little finger, and gives the chief arches

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in the palm of the hand, and all the arteries of the fingers, saving only the inner side of the fore finger. The radial artery goes off like a branch from the ulnar, or, in other words, the ulnar seems to continue in the course of the main artery, while the radial goes off to one side; it makes its appearance as a superficial artery much higher in the forearm than the ulnar does; its chief branch turns backwards over the wrist, or root of the thumb, and it gives all the arteries of the thumb and forefinger, as the ulnar does of the other fingers. The interosseous, again, is truly a branch from the ulnar; it comes off where the ulnar lies deepest; it runs along the interosseous membrane, whence its name; it belongs to the deep muscles of the arm; it scarcely passes the wrist, or at least mounts but a very little way along the back of the hand.

These are the greatest divisions of the artery; but before entering upon these, it will be well to set apart and describe one particular set of arteries, viz. the recurrents; both because they belong in a peculiar manner to the joint, and because the recurrents, from whichsoever of the great arteries they come, still serve the same office, viz. of inosculating with these from the above joint; though, after all, this part of their office attracts our attention, chiefly because we depend upon these inosculations for our success in operations for aneurism, though unquestionably the chief use of these arteries is to supply the joint and adjacent parts; and their inosculations are but a secondary office.

### ARTERIÆ RECURRENTES.

The recurrent arteries are small arteries corresponding with the anastomosing arteries from above. They turn quickly backwards almost as soon as they are clear of the main arteries from which they arise: they encircle the whole joint, for they are no less than four, or sometimes five, in number; one from the radial, two from the ulnar, and one from the interosseous artery.

### RECURRENS RADIALIS ANTERIOR.

The anterior recurrent of the radial artery is the first branch which it sends off, excepting a small branch to the supinator and skin. The place where the radial recurrent is to be found, is deep in the hollow betwixt the brachialis internus or muscle of the arm, and the extensor radialis or first muscle of the forearm, viz. that which constitutes its outer edge. The recurrent lies upon the forepart of the joint, where the outer condyle is: the muscles which lie over this recurrent artery, or near it, are the two flexors of this wrist, the supinator longus, and the biceps, and these receive its first branches; and one of its branches runs down along the tendon of the supinator. Its next branches go less regularly to the other muscles of the forearm, as to the pronator teres, and to the flexors of the fingers; it has one superficial anastomosing artery, whose anastomoses are not upon the naked joint; but, on the contrary, the branch

branch mounts along the forepart of the brachialis internus muscle, and inosculates under the biceps with the lesser or lower profunda. A second anastomosing branch goes deeper; it passes through the flesh or belly of the brachialis, and anastomoses with the ramos anastomoticus major from above. A third anastomosing branch is the chief branch; it lies deeper still upon the forepart of the joint, in the hollow which I have lately mentioned: it runs up under the belly of the supinator, along the forepart of the shoulder-bone, where it inosculates with the upper profunda humeri, and chiefly with its greater branch called spiral artery; which turns round the bone, and ends here over the outer condyle.

This is the recurrens anterior of the radial artery; but none of these branches have I ever seen or felt to be enlarged after operations for aneurism. The success of that operation depends entirely upon the arteries next to be described, viz. the ulnar recurrents, which are always two in number; but sometimes these two recurrents go off in one branch from the ulnar: in which case, viz. of a single recurrent coming off from the ulnar, it divides immediately into two branches, and the one takes the fore and the other the back part of the joint.

### RECURRENS ULNARIS ANTERIOR.

The anterior recurrent of the ulnar artery goes off the first of the branches, immediately before it gives off the interosseous, and where the artery lies deep in its triangular hollow. This anterior artery

passes up under cover of the pronator teres, lies close upon the forepart of the inner condyle, and is of importance, not only by its own size, but also by its anastomosing with the ramus anastomoticus major, which is the largest of the arteries from above.

### RECURRENS ULNARIS POSTERIOR.

THE POSTERIOR RECURRENT of the ULNAR artery is often a branch of the anterior one, coming off with it in one common trunk. When it comes off apart, it arises a little lower; it is a larger and stronger artery, i. e. it makes as full inosculations, goes farther, and gives more branches to the muscles. This posterior recurrent arises from the ulnar at that place where it perforates the bellies of the flexor muscles; it also dives through betwixt the two bellies of the flexor muscles of the fingers, it thus gets round the condyle, for these two muscles arise together, from the condyle: the artery gives many branches both to the pronator and flexor muscles, and to the periosteum, and capsule of the joint; it then lodges itself in the deep hollow which is betwixt the olecranum and the condyle, where the ulnar nerve lies (that nerve which we feel so benumbed when we strike the inner side of the elbow). The artery stretching upwards along the bone, meets a similar descending branch from the upper profunda, and inosculate with it. As far as we yet know, the whole weight of the business in saving the arm after aneurisms depends upon these two arteries. In Mr. White's preparation it is the anterior branch which is enlarged, inosculating

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with the anastomoticus major over the forepart of the inner condyle. In a preparation which I have, it is the posterior artery which runs tortous and enlarged behind the inner condyle: but I must add to the authenticity of this preparation, by noticing, that I have several times felt distinctly, after successful operations for the aneurism, that it was this posterior artery that was enlarged.

## RECURRENS INTEROSSEA.

THE RECURRENT of the INTEROSSEOUS artery is the first of its branches, though sometimes this recurrent rises from the ulnar a little above the interosseous. This artery going to the middle and back part of the joint is very constant; it first sends one smaller branch forwards towards the root of the brachialis internus muscle, which inosculates over the forepart of the joint with the ramus anastomoticus magnus, and with the ulnar and radial recurrents; but these inosculations and this anterior branch are of small importance. The chief branch goes through that lacerated-like hole which is in the upper end of the interosseous ligament; and the artery having passed through this hole, and got to the back of the joint, it runs for two inches upwards along the back of the olecranon, contributing greatly to form, by its inosculations with both branches of the profunda superior, that net-work of arteries which covers all the backpart of the joint, and which belongs chiefly to the joint, to the capsule, and to the bones which form the joint.

From these anastomosing branches which belong to all the three arteries, we now return to describe the general course of the three great arteries; and first of the radial.

ARTERIA RADIALIS.

The radial artery is properly the first branch of the ulnar; it goes off from it at a pretty obtuse angle in the bend of the arm; it passes under the pronator muscle, emerges from under it above the middle of the arm, follows the long tendon of the supinator, and runs under it down to the root of the thumb; it is at the root of the thumb only that it divides into its great branches: and a clear proof that in its course down the forearm it gives off none but small and irregular muscular branches, is this, that it preserves almost an equal diameter in all its progress from the elbow to the wrist.

This is the artery which lies naked upon the radius at the wrist, where we feel the pulse. It lies more superficial, less imbedded in muscles, than the ulnar artery; for six inches above the wrist there is to be felt nothing but the naked artery, the sharp tendon of the supinator, and the bone. The radial artery, as to its course down towards the wrist, is direct; but with regard to itself, it is tortuous, with short and gentle wavings. Of its branches, as it moves down the forearm, there is not one that is worthy to be named. First it gives a branch to the supinator, and to the extensors of the carpus; then it gives the radial recurrent, already described; then having gone a little deeper among the muscles, it repeats its branches to the

the supinator and extensors; but being deep, it gives also twigs to the pronator and to the flexor radialis, inosculating with the interosseous arteries. Next the radial artery, emerging from among the thickest of the muscles of the forearm, becomes superficial, touches the naked radius, and runs along it, with the belly of the flexor pollices below it and the long tendon of the supinator above it. Here are no muscles lying on the outside of it, nothing but the tendon; and therefore all its twigs are downwards to the flexor pollicis, upon which it lies; the flexor digitorum, which lies next to that; and to the flexor radialis and the palmaris longus. Next it gives deeper branches, viz. to the pronator quadratus; and also it gives small twigs, which accompany the several tendons along the naked bone. Arrived at the wrist, it does not divide, as authors have represented, into two branches, viz. a palmar and a dorsal artery, but quite the reverse; the radial artery passes on undivided to the root of the thumb, and there divides into three great branches; one to the thumb, one to the forefinger, and one to the palm of the hand: it does indeed, while it is passing the wrist, give two considerable branches, one to the palm, and one to the back of the hand; yet they are but branches.

### ARTERIA SUPERFICIALIS VOLÆ.

The first branch, then, of the radial artery, after arriving at the wrist, is that which goes across the palm of the hand, and may be named the SUPERFICIAL artery of the PALM. It goes off just where the main ar-

tery is about to turn over to the back of the hand; it passes in general through the flesh of the thumb, going under the root of ABDUCTOR BREVIS POLLICIS. This artery we generally find dividing into three branches: The first is a more superficial branch, which crosses the palm of the hand, and gives its twigs to the skin, palmar aponeurosis, annular ligament, and all the tendinous parts about the joint: The second is a larger and more important branch; it is the middle branch of these three; it goes deep; and having given several branches to the muscles about the root of the thumb, and to one or two of the interossei muscles, it makes a large inosculation with the great palmar arch, which seems to be indeed the chief tendency of the whole artery: The third branch is less regular than the others; it mounts along the root of the thumb, and belongs to its outer edge*.

The next branches of the radial artery are very small and nameless twigs, which go the naked part of the wrist, to the tendons, ligaments, and the bones; and then comes the artery opposite to this artery of the palm, viz. the artery of the back of the hand.

## ARTERIA DORSALIS CARPI.

THE ARTERY of the BACK of the HAND comes of from the radial, just after it has turned over the root

* This branch anatomists have thought fit to call ARTERIA ULNARIA RADIALIS POLLICIS, which involves such a complication of contradictions, that, upon reading it, one would naturally turn to the tables of errata. The artery is called radialis, because it comes from the radial artery; and ulnaris pollicis, because it goes upon the ulnar side of the thumb.

of

of the thumb. It takes its course directly across the back of the hand, over the carpal bones; and by its frequent inosculations with branches from the ulnar artery, and with the interosseous arteries, it makes beautiful net-works across all the naked part of the back of the hand. After this beautiful net-work, it sends twigs forwards, which lie close upon the bones, go to the muscles which lie betwixt the bones. The muscles are named interossei, and these twigs are named after them.

The first interosseous artery is large, long, goes up in a direct course to the fork betwixt the fore and mid fingers, and plunges into the cleft of the digital artery at right angles with it. The dorsalis manus gives then a second twig like this, and then a third; named the first, second, and third interosseous arteries: but they are all smaller than the first, and all the three communicate with the arteries from the palm.

Before the final division of the radial artery* into its three branches, it gives a third artery, or, as often happens, two arteries, to the back of the thumb.

### ARTERIA DORSALIS POLLICIS.

The small artery, or the two small arteries which, from going along the back of the thumb, are named arteriæ dorsalis pollicis, come off either along with, or imme-

* Notwithstanding the inconsistency of retaining the name of radial artery, after the artery has passed the wrist, and begun to run along the thumb, I venture to sacrifice verbal accuracy, and would make much greater sacrifices to obtain a clear arrangement.

immediately after, the dorsalis carpi. When there are two, they run both along the back of the thumb, one on one side, the other on the opposite side; that which runs along the outer edge of the thumb passes through under the tendons, and is rather shorter: that which inclines to the inner side of the thumb is rather longer. These small arteries on the back inosculate round the edges of the thumb with the great artery on the inner side; which is next to be described.

The radial artery having advanced to the wrist, turns quick round the wrist, over the head of the radius, and under the tendons of the thumb; it gives immediately before it passes the artery of the palm; it gives immediately after it passes the artery of the back of the hand; it gives immediately after that the little arteries for the back of the thumb; it then mounts along the thumb in that hollow which is by the side of the metacarpal bone of the thumb, till it arrives at the cleft betwixt the thumb and forefinger. There it divides into three great arteries; one to the inner side of the thumb, very large another to that side of the forefinger which is next the thumb, which branch is much smaller; and one which exceeds these in importance, for it dives down into the palm of the hand, forms what is called the deep arch of the palm; and which, having crossed the palm, forms on the side next the middle finger that inosculation betwixt the upper and lower arches which is so much celebrated.

ARTERIA

## ARTERIA RADIALIS INDICIS.

THE artery of the forefinger proceeding from the radial artery is the first and smallest of these three branches. It goes off at the root of the metacarpal bone of the forefinger, goes up along its interosseous muscle, and runs along all the edge of the forefinger next the thumb, inosculating with the artery of the opposite edge, which comes from the ulnar arch; it sends off twigs at its root, which inosculate with the small dorsal arteries of the thumb; and it gives a branch to the adductor addicis.

## ARTERIA MAGNA POLLICIS.

THE CHIEF ARTERY of the THUMB rises along its metacarpal bone, a single artery, and there splits commonly, I think, into three smaller branches. Two of these run along the forepart of the thumb up to its extremity, and inosculate there; the one running along the radial, the other along the ulnar side, till they meet at the point. These are, as it were, counterparts of the dorsal arteries, but greatly larger, the thumb being naked on the back, but fleshy where it looks towards the palm. Another branch of the arteria pollicis is one which turns across to the palm of the hand, and makes a smaller and more superficial inosculation with the palmer arch.

ARTERIA PALMARIS PROFUNDA.

The third branch of the radial artery, and that by which it ends, immediately succeeds the artery of the thumb. It crosses the palm of the hand so as to form the deep arterial arch, or the radial arch of the palm; it lies under the aponeurosis, and all the tendons and muscles close upon the metacarpal bones. Having gone its circle so as to complete the arch, and having arrived at the root of the little finger, or rather lower, near the pisiform bone, it turns backwards with a sudden serpentine turn, and enters into the side of the ulnar arch, so as to make a complete inosculation.

This deep palmar arch gives out many arteries; but as it lies close upon the bones, they are all of the smallest order of arteries, and go only to the bones, and to the joints, of the carpus and metacarpus. Those branches again which run upwards, give little arteries to the interossei muscles, to the lumbricales, to the long tendons, and to the interstice of each bone. Small twigs are sent through to the back of the hand, which are named arteriæ perforantes, and which inosculate with the dorsalis carpi, or artery of the back of the wrist; they also inosculate with the arteries of the fingers.

ARTERIA ULNARIS.

The ulnar artery, both from its size and its direction, is to be considered as the continued trunk. It dives downwards and backwards into the triangular

gular hollow which has been described, till it touches the interosseous membrane: It first gives off a small branch to the pronator teres and common origin of the flexor muscles, before it passes through them: Sometimes it gives off here the recurrent, which should come from the interosseous artery; in which case that branch, as it passes backwards through the interosseous membrane, is named interossea posterior suprema. Next the ulnar gives off the proper interosseous artery, which is named INTEROSSSEA COMMUNIS, because both the interior and posterior arteries are branches of it. Then the ulnar artery, lodged deep under all the muscles which go off from the inner condyle, as the palmaris, pronator teres, flexor ulnaris, &c. perforates one of them, viz. the flexor digitorum. But though it passes through betwixt the upper and lower flexor, it does not, like the radial, appear immediately as a superficial artery; it shows itself only about three inches above the wrist. The ulnar artery, running along by the tendon of the flexor carpi, turns over the wrist at the pisiform bone; it then forms the superficial arch of the palmer arteries and supplies all the fingers, as the radial supplies the thumb.

The arteries which the ulnar gives out after it passes through the muscles, and before it arrives at the wrists, are merely muscular branches, extremely variable in size and number. To enumerate these would be but to repeat the names of all the muscles which lie upon the flat part of the forearm.

As the radial sends a branch over the back of the hand, named dorsalis radialis, so does this send a

branch

branch round the back of the little finger named dorsalis ulnaris.

### ARTERIA DORSALIS ULNARIS.

The dorsalis manus ulnaris is a small branch which goes off from the ulnar artery as it advances towards the wrist. The ulnar artery goes forwards towards the pisiform bone, while this little artery turns off about two inches below, passes under the tendon of the flexor ulnaris, and round the head of the ulna, to the back of the hand; it then goes upwards along the back of the little finger, where it ends. It gives branches as it passes along to the pronator quadratus, to the extensor ulnaris, to the joints about the lower part of the wrist, and especially to the joining of the radius with the ulna; and it finishes on the back of the hand by arteries given to the tendons and capsule, by inosculations with the rete which is formed upon the back of the wrist, by the radial artery, and by giving the dorsal artery of the little finger.

Next the ulnar artery, before it begins its arch, gives small branches to the flexor tendons and forepart of the wrist; others to the pisiform bone, to the annular ligament, and to the palmaris cutaneus, and then branches to the flexor, abductor, and adductors of the little finger; or, in other words, to all that mass of muscular flesh which surrounds the root of the little finger; and still before it begins to bend into an arch, and just beyond the pisiform bone, it gives off that branch which may be called ARTERIA PALMARIS PROFUNDA.

ALTERIA PALMARIS PROFUNDA.

The description of this artery is shortly this: It is but a small artery; it comes off a little lower than the pisiform bone; it often gives the last lateral artery of the little finger; it then turns downwards and backwards with a large circle, passes through betwixt the two heads of the flexor digiti minimi; by this it gets into the deepest part of the palm, and there joins itself with that palmar branch of the radial artery which comes off at the root of the thumb; and by this inosculation the deep palmar arch is completed.

The ulnar artery having now arrived at the root of the metacarpal bones, forms a great arterial arch across the palm of the hand, which is named the SUPERFICIAL PALMAR ARCH; and this arch gives out the arteries for the fingers after the following order: It does not give off two arteries to each finger, one for each side, because it does not lie at the root of the fingers, but lower down: but instead of this it sends out three single arteries; each of these goes to the cleft betwixt two of the fingers; and when arrived at the roots of the fingers, these branches divide uniformly and regularly into two branches; of which one goes up along the side of one finger, while the other goes up the opposite side of the next finger; and thus all the fingers are supplied each with two arteries, one running along either edge of each finger. To number them according to the fingers one, two, three, were mere drudgery, and waste of time; and to name and describe them were an absolute abuse, since they

they are so uniform in all points: It is sufficient to observe, that a long and slender artery runs along each edge of each finger; that generally at each joint or division of the finger the two arteries make arches to meet each other across the hollow where the tendons lie, supplying the tendons and ligaments at the same time; and that the fork of each digital artery receives a branch from the deeper arch of the palm. That the arteries are each accompanied with corresponding nerves, one for each side of each finger; for the ulnar nerve accompanies the ulnar artery down the fore-arm, and branches along with it in the palm into the form of an arch, with three branches; which three branches are afterwards divided like the arteries, each into two twigs at the roots of the fingers.

The superficial palmar arch finishes with a small branch, which makes another inosculation at the root of the thumb with that superficial palmar branch which comes off from the artery of the thumb, near the place where the artery of the forefinger also comes off.

### ARTERIA INTEROSSEA.

The interosseous artery is, after the radial and ulnar, the last of the arteries of the forearm. It is but a branch of the ulnar; it arises from the ulnar just where it lies in the very deepest part of the arm, touches the interosseous ligament. This artery is named interossea communis, because of two lesser interosseous arteries into which it divides. First the interossea communis divides about an inch below

below the elbow into the interossea anterior and interossea posterior: next the interossea posterior gives off the posterior or interosseous recurrent. That artery is already described; and I proceed to describe now the course of the two interosseous arteries.

First, The anterior interosseous artery is the continued trunk, for it goes straight forwards, and is larger; while the posterior interosseous is smaller, turns out of the straight course to perforate the membrane, and is exhausted before it reaches the wrist.

The anterior interosseous artery lies flat upon the forepart of the interosseous membrane; is larger than a crow-quill, or about half the diameter of the radial artery. As it goes down the forearm, it gives branches to all the muscles; it gives the nutritious arteries of the radius and ulna; it goes forwards, and, ending in small branches under the anular ligament of the wrist, it makes beautiful net-works and anastomosis over the capsular joints of the carpus.

Secondly, The posterior interosseous artery turns through the interosseous ligament about two inches below the elbow-joint. It instantly gives off the interosseous recurrent; which being very large, the artery seems to be divided into two equal branches, of which one is the recurrent, turning upwards towards the elbow-joint; the other is the posterior interosseous itself, running downwards, and distributing its branches among all the great bellies of the extensor muscles which lie on the outside of the forearm.

Thirdly, There is something like a second interossea posterior; for the anterior interosseous artery sends off, about four inches above the wrist, another artery,

 but

but much smaller, which perforates the interosseous membrane; might be called a second posterior interosseous; though it is rather to be reckoned among those smaller twigs which, coming off from the anterior interosseous, and perforating the ligament, go through it to the extensor muscles, and are named PERFORATING ARTERIES, being from about four to seven in number.

## CHAP. III.

## THE ARTERIES OF THE THORAX, ABDOMEN, AND PELVIS.

### § 1. ARTERIES OF THE THORAX.

#### AORTA THORACICA.

THE aorta from the arch (where the subclavians and carotids go off) bends downwards and backwards, and touches the left side of the spine. The two membranes called pleura of the right and left side meet in the middle to form the mediastinum; but as they do not meet immediately, they leave a triangular space, the basis of which triangle is the spine; the sides are the two membranes of the pleura, inclining towards each other; and there, in the interstice betwixt them, the

the aorta is lodged, and along with it lies the œsophagus, which runs downwards towards the stomach The thoracic duct, which is passing upwards to the subclavian vein, and the vena azygos, which returns the blood of the thorax, and brings it into the descending cava; these parts are all involved in cellular substance, and inclosed in this triangular space betwixt the two membranes.

The aorta, as it goes thus downwards besides the spine, gives the following branches: First, As it lies immediately behind the root of the lungs, it gives small arteries which nourish the proper substance of the lungs, the bronchial arteries: Secondly, As it lies by the side of the œsophagus, it supplies it with small twigs, the œsophageal arteries: Thirdly, The aorta, as it moves downwards through the thorax, gives off a small and regular artery to the interstice of each rib as it passes it; and these are the INTERCOSTAL ARTERIES.

The BRONCHIAL arteries are always three, and sometimes four, in number. Their office is not to contribute to the oxydation of the blood; that office belongs peculiarly to the pulmonic artery, while the small bronchial arteries are for nourishing the proper substance of the lungs; for which end they attach themselves immediately to the trachea, and follow its branches, twisting round them through all the substance of the lungs.

### 1. ARTERIA BRONCHIALIS COMMUNIS.

THE COMMON BRONCHIAL ARTERY, so named because it gives branches to both sides of the lungs,

 arises

arises highest from the forepart of the aorta; it gives two branches, one to the right side of the lungs, and one to the left; the right branch gives an artery to the œsophagus, and sometimes the whole of the right branch goes to that part.

### 2. ARTERIA BRONCHIALIS DEXTRA.

THE RIGHT BRONCHIAL ARTERY sometimes, like the common bronchial, comes off from the aorta; but very often it comes off from the upper intercostal artery. It goes round the right branch of the trachea, and belongs to that side of the lungs alone: but it gives, notwithstanding, some branches to other parts, especially to the œsophagus, to the back of the pericardium, and to the posterior mediastinum, or membrane which strides across the aorta.

### 3. ARTERIA BRON HIALIS SINISTRA.

THE LEFT BRONCHIAL ARTERY comes off along with the bronchialis communis from the forepart of the aorta; it goes to the left side of the lungs, and also affords small branches to the œsophagus and neighbouring parts.

### 4. ARTERIA BBONCHIALIS INFERIO R.

OFTEN there is a fourth bronchial artery, which we would call BRONCHIALIS INFERIOR, or the LOWER BRONCHIAL ARTERY, because it comes off lower than these, commonly about the place of the fifth rib. It goes to the back of the heart, where the pulmonic vein of the left side expands into the auricle, and taking

taking the pulmonic vein as a conductor, creeps backwards along it into the substance of the lungs.

These bronchial arteries are the least regular in all the body, coming off usually from the aorta, but sometimes from the mammary, and often from the upper intercostal artery; sometimes also they arise from the intercostals of the aorta. But from one or other of these sources we usually have three or four bronchial arteries, which are so named from their belonging to the branches of the trachea or bronchiæ.

Ruysch, who first discovered this artery, and Sylvius de la Boe and others who followed Ruysch, and used his words in describing the artery, explained its office truly: they said it was for nourishing the substance of the lungs. But this sensible opinion was disputed by many physicians of very great reputation; who maintained that it was quite disproportioned to the size of the lungs, and that it nourished the trachea only; and they gave a most whimsical reason for believing all this. The lungs they considered as made of very coarse stuff, which the half elaborated blood of the right ventricle and pulmonic artery might serve; while the harder and more perfect substance of the trachea required a more perfect and finer blood.

### 5. ARTERIÆ ŒSOPHAGEÆ.

The æsophageal arteries are generally five or six in number. They are small twigs which come off from the aorta below the bronchial arteries; they encircle the œsophagus, and make anastomoses with

 each

each other; and very generally they pass off from the œsophagus to the posterior mediastinum, or that double membrane under the interstice of which the aorta lies. These secondary arteries, along with very small twigs which come off from the aorta itself, some anatomists choose to describe apart under the title of posterior mediastinal arteries.

### 6. INTERCOSTALES INFERIORES.

THE LOWER INTERCOSTAL ARTERIES are nine or ten in number, according to the number of ribs which are not supplied by the upper intercostal artery (for the upper intercostal, which comes downwards from the subclavian artery, supplies usually the intercostal spaces of the two first ribs), but sometimes of three, and sometimes of one only. The aorta, in its course down the back, gives out, as it passes each vertebra, one artery for each rib; as it goes down along the loins it still gives off an artery at the interval of each vertebra; in the thorax they are named INTERCOSTAL, and in the loins the LUMBAR arteries.

The right intercostals are longer, because they have to mount over the ridge of the vertebræ; the left ones are shorter, because the aorta lies on that side of the spine: the intercostals often give small twigs to the œsophagus and mediastinum; but besides these, each intercostal artery gives three principal branches.

1. By the head of each rib it gives a small artery, which belongs entirely to the spine, and this artery sends one twig to the substance of each vertebra; another twig goes to the sheath or dura mater of the spinal marrow; the third, following each intercostal nerve

nerve backwards, enters into the substance of the spinal marrow itself.

2. Each intercostal gives next a larger artery, which perforates near the head of each rib, and passes through to the back, and supplies the longissimus dorsi, latissimus dorsi, sacro-lumbalis, and all the great muscles of the back, which have indeed no other source whence they can derive arteries; and though these are apparently small for so great a mass of muscular flesh, that smallness is compensated for by their frequency.

3. The intercostal artery proceeds, after giving these branches, along its proper intercostal space, where it gives an immense number of small arteries to the intercostal muscles; and as each artery passes round the thorax along the ribs, it splits into two branches; one attaches itself to the lower edge of the rib above it, where there is a sort of groove to receive it, that is, the larger artery, and the artery which is to be feared in wounds or operations; the other attaches itself to the upper sharp edge of the lower rib, where there is no groove; this of course is the smaller branch, much less important in all respects. These two accompanying each rib, run round the circle of the thorax to its forepart, and inosculate with the mammary and epigastric arteries.

## § 2. ARTERIES OF THE ABDOMEN.

### AORTA ABDOMINALIS.

THE aorta descends into the belly under that arch which is formed by the legs of the diaphragm. It passes along the left side of the spine; but now, upon emerging into the abdomen, it inclines nearer to the middle of that ridge which is formed by the vertebræ. The flat and tendinous legs of the diaphragm not only stride over the aorta, so as to form an arch apparently for its protection; but the uppermost part of the crura turns flat under it, so as to embrace it. No vein goes along with the aorta; for the cava, which returns all its blood, leaves it a little above the pelvis, and inclines towards the right side, that it may enter into the right side of the heart, which it does by passing under the liver.

But the aorta has other very important connections; for as one of its first arteries is the great artery of the intestines, of course the root of the mesentery (the membrane which conducts the arteries of the intestines) lies over the aorta; and as the mesentery conducts the lacteals from the intestines, of course the meeting of the lacteals and of the lymphatics, or, in other words, the beginning of the thoracic duct, is at the side of the aorta. Again, as the great nerves which come down from the breast into the abdomen are destined

tined chiefly for the viscera, they have no other way of reaching the viscera than by taking the direction of the several branches which the abdominal aorta gives out. There are three great branches; the cœliac, the superior mesenteric, and the inferior mesenteric arteries. Of course there are three great plexus of nerves; the cœliac plexus, the superior mesenteric plexus, and the inferior mesenteric plexus. As these net works all come from the greater net-work which covers the aorta itself, that plexus is named, from its great size and from its many radiated nerves, the solar plexus; and the semilunar form of the two great nerves which supply the whole gives them the name of semilunar ganglions.

These connections of the aorta, deduced in this general way, will be easily understood; will show the importance of studying this point, where there are so many intricate parts; and will explain also the necessity of mentioning this group of difficult parts at once.

The aorta then passes from the thorax into the abdomen, through betwixt the legs of the diaphragm; the beginning of the thoracic duct lies a little below this point, and the duct itself runs up by the side of the aorta; the great Splanchenic nerve, or that which goes to the bowels, attaches itself as soon as it enters the abdomen to the side of the aorta, and swells out into the semilunar ganglion or knot: So that the semilunar ganglion of each Splanchenic nerve lies along each side of the aorta; the smaller nerves which these ganglions give out meet across the root of the abdominal aorta, to form the solar plexus; and next the

cœliac

cœliac and mesenteric plexus arise chiefly from that solar one.

The aorta, thus connected, having come out into the abdomen, the first branch which it gives off naturally is a small one to the diaphragm as it passes under it. The next branch which it gives off is the most important of all, viz. the cœliac artery; and it supplies the stomach, the liver, and the spleen, because they lie in the upper part of the abdomen. Next it gives a great artery to the intestines, which is named the superior mesenteric artery; for it goes to the intestines which lie within the abdomen. And, lastly, it gives off a great artery, which is named lower mesenteric; because it supplies chiefly the lower part of the great intestines, and most especially the rectum, where it goes down into the pelvis.

Then the aorta divides into the two iliac arteries, and of course has no longer the name of abdominal aorta.

### ARTERIÆ PHRENICÆ.

The diaphragm has in nine of ten bodies two arteries named the PHRENIC ARTERIES; one going to the right side, the other to the left. The varieties of this artery are too great almost to be mentioned; but, however, these are the chief: Generally the phrenic arteries are two small arteries arising from the aorta, one going to the right side, another to the left; often there is one artery going off from the forepart of the aorta, and dividing immediately into two arteries, right and left; sometimes one arises from the aorta itself, another from the cœliac artery; sometimes the cœliac artery, which has properly

properly but three branches, has a fourth added, which is the phrenic artery; sometimes there are three phrenic arteries, sometimes even four; and the diaphragm, it is always to be remembered, receives often smaller branches from the intercostal and lumbar arteries, or from the capsular arteries, besides those which it gets from the thorax along with its nerve coming along the pericardium.

These varieties being mentioned, the history of the regular phrenic arteries may be very short. One goes round the right side of the diaphragm, and the other round the left, with very little variety. First the phrenic artery crosses what is called the fleshy part of the crus diaphragmatis of its own side, and goes bending along to what is called the ala or wing of the diaphragm, and gives a great many arteries in all directions into these fleshy sides of the diaphragm; the artery then turns round, and encircles the great central tendon, where the two phrenic arteries begin to turn round: they give one branch particularly large to the fleshy sides of the diaphragm, which arise from the ribs; then bending round the central tendon, they spread all their remaining branches forwards upon the central tendon, and upon that part of the muscle which arises from the sternum, and meet in large inosculations with each other. One branch often pierces the diaphragm, goes into the pericardium where it is attached to the diaphragm, and unites with that artery which comes down along with the phrenic nerve, the comes nervi phrenici.

But still it is to be remembered, that the phrenic arteries, before they enter into the diaphragm, give small

small arteries to the capsulæ renales, and to the œsophagus and neighbouring parts; the œsophegean branch running upwards into the thorax, to inosculate with the upper arteries of the œsophagus.

## § 3. OF THE ARTERIES OF THE STOMACH, LIVER, AND SPLEEN.

THE upper part of the abdomen is occupied entirely by the stomach, liver, and spleen; the stomach in the middle, the liver on the right hand, and the spleen on the left. The cœliac artery supplies all these parts; it rises up from the forepart of the aorta a short thick artery encircled by the lesser arch of the stomach; and immediately splits into three branches, of which the middle branch goes to the stomach, the left goes to the spleen, the right goes to the liver; and thus we have all the branches of the cœliac artery neatly and simply arranged.

### ARTERIA CŒLIACA.

THE CŒLIAC ARTERY is so important, that its place and connections must be more minutely described. It arises from the forepart of the aorta, just at that place where the aorta is closely embraced by the crura diaphragmatis, and over the eleventh vertebra of the back; it juts directly forwards, almost at right angles from

from the aorta, and is encircled by the lesser arch of the stomach; the artery standing up betwixt it and the diaphragm. The cœliac trunk, then, is so placed as to be surrounded by these parts; it has the œsophagus on the left hand; the lobulus spigelii, or lobulus papillaris of the liver, on the right hand; it has the lesser arch of the stomach making its turn under it; and it has the diaphragm above, and the pancreas running across below; it is covered by the delicate web of the omentum, named omentum minus, which goes from the lesser arch of the stomach to the liver and to the spine.

Now this short jutting out or stump we call the trunk of the cœliac artery; or we call it axis arteriæ cœliacæ, for there is no other artery of the body that divides like it: the stump, which is less than half an inch in length, serving as an axis, from which the three great branches, viz. to the stomach, liver, and spleen, go off all at once, in a tripod like form; one upwards, one to the right, and one to the left. The hepatic, which goes to the right, is largest in the child, because of the great bulk of its liver; the splenic, which goes to the left, is larger in the adult; the gastric is almost always the smallest of the three.

### 1. ARTERIA CORONARIA VENTRICULI.

The coronary artery of the stomach is the central artery of the tripod. When it belongs entirely to the stomach, it is smaller than the splenic or hepatic arteries: but when it gives (as often it does) a branch to the liver, it is the largest of the three. This gastric artery, or coronary artery of the stomach, is generally

the

the smallest, not very much larger than a crow-quill; it rises upwards, and turns a little towards the left side, because the pyloric orifice of the stomach is there.

Before it reaches the pyloric orifice of the stomach, it divides itself into two great branches; one going round the cardial orifice of the stomach, and the other returning along the lesser arch.

### CORONARIA SUPERIOR VENTRICULI.

The branch which belongs to the cardiac orifice of the stomach attaches itself to the œsophagus, just where it emerges from the diaphragm, and is joined to the stomach: the artery turns round the œsophagus, passes first under and behind it, and then turns round and appears on the forepart, or rather on the left side, of the stomach to spread over it. In the middle of this turn it gives off an artery which runs backwards along the œsophagus, takes directly the line of the œsophagus, runs up with it into the thorax a considerable way, inosculates with the upper œsophagean arteries, and though a small branch, it is long, and seldom awanting. The second branch is a continuation of the same artery encircling the cardia, sending its arteries down over the large and bulging part of the stomach, somewhat in the form of a crown. As the spleen is attached to this end of the stomach, this artery inosculates with what are called the vasa brevia, or short vessels coming from the spleen; and so it ends, having the name of CORONARIA SUPERIOR VENTRICULI.

The second branch of the coronary returns along the lesser arch of the stomach; it is so connected with the last that it may be called ramus coronariæ

dextra,

dextra, though properly it is not a branch, but the continued trunk of the gastric artery. As the first branch turns round behind the œsophagus, this stops and turns to the lesser arch of the stomach, touches it just at the cardiac orifice, *i. e.* at the root of the œsophagus; turns with a gentle turn round the lesser arch of the stomach, bending as the arch bends, giving its branches down both forwards and backwards over each side of the stomach. As it runs along the stomach it is sensibly exhausted by these arteries, so that it arrives very small at the lower or pyloric orifice of the stomach; there it turns over from the stomach upon the small gut in such a way as to belong to the pylorus or union of the gut with the stomach; and though small and trivial, it has an appropriated name, ARTERIA PYLORICA SUPERIOR, and thus the gastric artery ends.

But sometimes, as has been mentioned in the general description, the gastric artery sends a branch to the liver; yet, in that case, the order of these arteries already enumerated, is in no degree disturbed; the artery running along the œsophagus, the artery running round the cardia and in form of a crown, the artery returning along the lesser arch, are still the same; only, after giving off this last artery, the trunk of the gastric goes off from the stomach, continues its course towards the liver, and passes into it.

### 2. ARTERIA HEPATICA.

THE HEPATIC ARTERY goes off from the cœliac axis, where it almost touches the point of the spigelian

lian lobe. The pancreas covers the root of the hepatic artery; it then turns a little forwards, and rising somewhat upwards at the same time, it passes under the pylorus, *i. e.* under the stomach and duodenum; it passes behind the omentum minus and biliary ducts; it arrives at the porta where the great vena portæ enters the liver, and where the biliary ducts come out; it passes betwixt the biliary ducts and the vein; and having divided a little before into two great branches, these now enter into the right and left lobes of the liver. In this place it is inclosed along with all the other vessels in that sheath of cellular substance which is called the capsule of Glisson.

Thus the artery finally terminates near the liver in two great branches, right and left; but before it does so, it gives, as it passes the stomach, duodenum, pancreas, very important branches to these parts. Before it gives these more important branches, it gives small twigs to the vena portæ and to the head of the pancreas; then it gives off the great artery which is the source of these lesser arteries (to the pylorus, pancreas, and duodenum), viz. the ARTERIA DUODENO-GASTRICA, which, soon after it goes off from the hepatic artery, divides into two chief branches. One turns backwards along the duodenum to the stomach, and from supplying the stomach and epiploon, is named GASTRO-EPIPLOIC ARTERY. The other, turning downwards along the duodenum, gives at the same time arteries to the pancreas, and so is named ARTERIA PANCREATICO-DUODENALIS. The trunk which divides into these

two

two arteries may be described thus: The duodenum begins from the pylorus; the pancreas pours its liquor into the duodenum; and therefore the head of the pancreas is attached to the duodenum: this marks the point at which the trunk of the ARTERIA DUODENO-GASTRICA goes off; for it rises at right angles from the hepatic; it lies behind the lower end of the stomach just between the pylorus and pancreas; there it splits into its two great branches, viz. to the duodenum and to the stomach. But besides these two great branches there are subordinate arteries, which must be enumerated together with them.

One artery goes off to the upper and back part of the duodenum over the biliary ducts; next go off small arteries to the duodenum of still less importance, and nameless; and at the same place small twigs are often given to the pancreas.

The first which is distinguished or regular, or has a name, is the PYLORICA INFERIOR, the lower pyloric artery. It goes off from the PANCREATICO-DUODENALIS almost as soon as it touches the duodenum; there are sometimes two or more pyloric arteries going off at this point; they encircle the pylorus with delicate branches; and at the same time turn obliquely upwards, to receive inosculations from the upper pyloric, which comes from the artery of the stomach.

The next artery to be distinguished by a peculiar name is one which goes off directly opposite to this, belongs to the pancreas, and is named, from its running transversely across the pancreas, the TRANSVERSE PANCREATIC ARTERY. It is a neat small branch,

which passes under the pancreas, runs along its back part, gives its arteries into the substance of the pancreas from side to side; and yet is not exhausted till it has run along more than two thirds of the length of this long gland.

The next branch is that from which the whole artery has its name: for the artery having given off the lower pyloric artery, and the transverse artery of the duodenum, turns downwards, bending according to the circle which the duodenum makes, lying in the hollow side of that circle just as other mesenteric arteries lie along their proper intestines. In all this circle it gives continual arteries outwards to the duodenum; it gives also frequent arteries inwards to the pancreas. From these two connections this branch is peculiarly named ARTERIA PANCREATICO-DUODENALIS. It ends in inosculation with the mesenteric artery.

At the place where the pancreatico-duodenalis turns downwards, the other great branch turns backwards and upwards to reach the stomach. It is so great that it must be considered as the continuation and ultimate part of the artery. It goes to the stomach and epiploon, and thence is named gastro-epiploic artery.

The course of the gastro-epiploic artery is along the lower part of the stomach, and is most beautiful; it makes a broad sweep round all the greater arch of the stomach; it lies in that line where the great omentum comes off from the stomach; it sends many and large branches upwards upon the stomach, both on its fore and on its back surfaces; it sends opposite branches, very frequent and considerable, down into the web

of

of the omentum or epiploon; it runs along the stomach till it meets with a similar branch from the splenic artery; and the inosculation between them is so large and perfect, that we cannot tell where the one artery ends or the other begins. This branch from the hepatic artery is named the right artery of the stomach, or the right GASTRO-EPIPLOIC ARTERY, while that from the splenic artery is the left.

Besides this great artery to the duodenum and stomach, the hepatic artery, before it plunges into the liver, gives another branch, but small; it is named pylorica superior hepatica.

### PYLORICA SUPERIOR HEPATICA.

THE PYLORICA SUPERIOR HEPATICA is so named to distinguish it from that upper pyloric artery which comes down from the stomach, and sometimes it is called GASTRICA vel CORONARIA MINOR. It comes off from the hepatic just before it divides, or immediately after from the left hepatic. It turns backwards at an acute angle to the lesser arch of the stomach, and having given small twigs to the omentum minus, it goes directly to the pylorus, inosculating with its upper and lower arteries.

### HEPATICA SINISTRA.

THE hepatic artery, now advanced to within about two inches of the liver, divides into its two great arteries. Both go to the porta of the liver; but the one belongs to the right lobe, the other belongs to the left. The artery which belongs to the left lobe of the

liver is smaller, and when there is an hepatic artery from the stomach it is very small; it mounts over the vena portæ, and enters into the liver at the fossa umbilicalis; its branches within the liver go chiefly to the left lobe, lobulus spigelii, and anonymous lobe.

### HEPATICA DEXTRA.

The right branch of the hepatic artery passes under the biliary ducts, enters along with them into the right lobe of the liver, and before it does so it gives off the arteria cystica, or artery of the gall-bladder, one of the most beautiful little arteries in the body. The cystic artery branches over the gall-bladder betwixt its coats, in the form of a coronary artery, and having made a beautiful tree of branches over the gall-bladder, it passes off from it, and goes to the substance of the liver.

### ARTERIA SPLENICA.

The splenic artery is one of the most remarkable in the human body. The spleen is tied down to the left side of the diaphragm by a proper ligament; it is also connected with the greater or bulging end of the stomach by processes of the omentum and by vessels. The splenic artery, the largest branch of the cœliac, as large as a goose-quill, turns off from the cœliac trunk almost at right angles, and runs a foot in length across the abdomen to get to the spleen. It is in all this course exceedingly tortuous; it runs along the upper edge of the pancreas (which also lies across the

the abdomen), and gives arteries to it; when it approaches the spleen, it gives off that great artery which returns along the lower border of the stomach, and when it actually arrives at the spleen, it divides into a great many branches, which enter by the concave surface of the spleen, and plunge into its substance.

The branches then, of the splenic artery, are these; 1. It gives a great artery to the pancreas named PANCREATICA MAGNA, which passes to the right under the pancreas, and belongs chiefly to the head of the pancreas, or that rounded end which is next to the duodenum. Though named magna, it is a variable artery, and of little importance. 2. All along, as the splenic artery is passing to the left by the border of the pancreas, it sends short branches into it. They are named PANCREATICÆ PARVÆ, or small PANCREATIC ARTERIES. 3. It often sends small arteries upwards to the back part of the stomach named POSTERIOR GASTRIC ARTERIES. 4. The GASTRO-EPIPLOICA SINISTRA, or the left gastro-epiploic artery, is a very large and principal branch of the splenic artery. It arises under the stomach a little beyond the left or larger head of the pancreas; it makes a large arch, and then turns with a serpentine turn towards the stomach, returns along the lower border of the stomach within the doubling of the omentum, and gives its arteries upwards to the stomach and downwards upon the omentum, so much like those of the right gastro-epiploic artery, that when they meet in the middle of the great arch of the stomach, and inosculate, we cannot distinguish where either of them ends; the chief difference is, that

 some

some of the epiploic branches of this artery are particularly large. 5. The VASA BREVIA are a set of three or four arteries which the splenic gives off just before it enters into the spleen; and as the artery lies close to the stomach, these arteries which go to the great bulging of the stomach are exceedingly short, and are thence named vasa brevia. The artery ends by eight or ten branches, which plunge into its substance. Sometimes we see the artery pass, almost undivided, or divided into one or two branches only, into the bosom or sinus of the spleen.

These are all the arteries of the stomach, liver, and spleen, the viscera which fill the upper region of the abdomen.

## OF THE ARTERIES OF THE INTESTINES.

### OF THE UPPER AND LOWER MESENTERIC ARTERIES.

THE bowels are so disposed within the abdomen, that the largest of them, viz. the colon, the great intestine, encircles all the others. It begins on the right side in a blind sac called the caput coli, or head of the colon: it goes upwards, and crosses the belly, so as to support the stomach, and separate the stomach, liver, and spleen, from the small intestines: it descends again into the pelvis at the left side, forming the rectum; and all the small intestines hang by their mesentery in the central part of the abdomen, surrounded by this great intestine;

intestine; and the arteries lie within the two lamellæ of the mesentery or supporting membrane of the intestines, so that they are called mesenteric arteries; and they follow the intestines in the order in which I have named them.

The GREAT OR SUPERIOR MESENTERIC ARTERY gives its first branches to the caput coli; its next branch to the middle of the colon under the stomach; the thousand turns of the small intestines next absorb all its other branches. The LOWER MESENTERIC ARTERY which gives no branches to the small intestines, attaches itself to the left side, and especially to the lowest part of the colon, and goes down with the rectum into the pelvis, and ends there. This, then, may serve as a general plan or arrangement for the intestines and for the two mesenteric arteries.

### 1. MESENTERICA SUPERIOR.

IT is not surprising that the UPPER MESENTERIC is the largest of all the abdominal arteries. It arises from the aorta, where it is still betwixt the legs of the diaphragm, and not more than half an inch below the cœliac artery. The cœliac and mesenteric arteries lie close upon each other; only we are less sensible of their nearness by the axis cœliacæ jutting perpendicularly forwards, and by the trunk of the mesenteric running very obliquely downwards, and by the head of the pancreas lying immediately over the mesenteric and hiding its root. The trunk of the mesenteric artery passes under the pancreas, then through the mesocolon

or mesentery of the colon, then into the proper mesentery of the small intestines. It turns first to the left; and then, by a second gentle bending, it turns again towards the right side of the abdomen. It runs very low into the abdomen before it gives out any branches; and then it gives them off in the following order.

From the right side it gives branches to the great intestines, of which there are three chief arteries; but, from the left side, where it gives arteries to the small intestines, it gives innumerable branches, very large, and so inosculated with each other, that they form a sort of mesh or immense plexus in the mesentery before they go onwards to the guts. The undivided trunk of the artery is very large and long; the gentle curvature of it from left to right gives it the form of an Italic *ſ*; the prodigious size of that mesh or plexus of vessels which goes to the great intestines is such as to carry the artery down to the left ilium or flank where the caput coli or conjunction of the ilium with the colon lies.

It is from the convex of this gently bending arch, and from the right or outer side of the artery, that the following arteries to the great intestines go off*. The COLICA MEDIA to the middle of the great intestine, the COLICA DEXTRA to the right side of the great intestine, the ILEO-COLICA to the joining of the ilium

* Often before giving off its greater arteries, the mesenteric gives to the pancreas several small arteries; and to the duodenum two or three, which are sometimes named under the title of duodenales inferiores.

with

with the caput coli or beginning of the great intestine.

### COLICA MEDIA.

1. The middle colic artery passes along in the doubling, *i. e.* betwixt the two lamellæ of the mesocolon. It goes with a circular sweep upwards towards that part or corner (as we may call it) of the colon which lurks under the liver; but before it touches the intestine, and generally at the distance of about three or four inches from it, this artery divides into two great branches; one turning backwards, along the right side of the colon, inosculates with the colic arteries; the other, more like the continued trunk, turns upwards, bending according to the curvature of the arch of the colon, which supports the stomach; and having rounded the concave of this arch, and arrived at the left side, it there makes a great inosculation with the left colic artery, which is a chief branch of the lower mesenteric; and so completes the great mesenteric arch, one of the most celebrated inosculations in the whole body, that of the circle of Willis hardly excepted.

### COLICA DEXTRA.

2. The right colic artery in enumerated as a distinct artery, chiefly for the sake of plainness; for though sometimes it arises apart from the general mesenteric trunk, yet in ninety-nine of one hundred bodies it proceeds from the upper or middle colic artery. It is a very large branch; it is set off from the colica media at a very acute angle; it moves

moves along the right side of the colon, inclining also a little upwards towards the liver; it also splits when it approaches the gut into two branches; one turning towards the upper side to inosculate with the middle colic artery, the other turning downwards towards the ilium or flank to inosculate with the ileo-colic artery.

ARTERIA ILEO-COLICA.

3. THE ILEO COLIC ARTERY arises about an inch lower than the last. It is a long, small, and slender artery compared with the two last; which are short, stumpy, and with contorted angles. This artery goes to the place where the small intestines end, and the great ones begin; of course the membrane which holds the intestines at this corner (I mean in the right haunch) changes its name from MEZZO-COLON (in the middle of the colon) to mesentery, or MEZZO-ENTERON, (in the middle of the intestines); and of course the ileo-colic artery runs down, not along the mesocolon, but along the mesentery. It goes directly down towards the joining of the ilium with the colon; it ends in three regular branches; one passes straight onwards to the junction of the ilium and colon, splits into two branches, one going over the fore and the other over the back part of the caput coli, and having a very curious correspondence with the valve within, so that it might be called ARTERIA VALVULÆ COLI. While this branch goes straight forwards over both sides of the caput coli, another branch runs backwards along the colon, and inosculates with the right colic artery, and another runs down

downwards along the ilium, and inosculates with the common branches of the mesenteric artery. It is from these two branches, which diverge like the rest of the colic arteries, that this is called ILEO-COLICA. Even the appendix vermiformis has its little mesentery tying it down to the caput coli, and from the back of the caput coli a little artery runs down upon that mesentery to the appendix, passing along the whole length of that process.

From this point all the remaining arteries of the mesenterica superior go to the small intestines; and they are so undistinguished, and so prodigiously numerous, that no branches can be described or named; there is nothing but a great net-work of arteries to describe. The first or radical branches which go to the small intestines, are thick, large, short, and vary from twelve to fifteen or twenty in number. But it is not these that make this vast appearance of a net-work; these twelve branches are first joined to each other, as it were mouth to mouth, forming one great confluence of arterial arches: from these, secondary branches arise, and they unite again in like manner, and make a second row of arches; from the union of these still other arteries arise, and make a third, or fourth, and even a fifth, row of arches, before any arteries go to the intestines; till at last the proper arteries of the intestines go out in straight lines from the last arch, and spread upon the coats of the intestines. In short, the mesentery has a very intricated and matted appearance; from the redoubling of these arches, which are more and more numerous as the artery proceeds lower, till the last of the twelve radical

branches

branches makes an arch, which serves the ilium or lowest of the small intestines, and inosculates with the ILEO-COLIC ARTERY.

## 2. MESENTERICA INFERIOR.

THE LOWER MESENTERIC ARTERY is that which is named by Haller the left colic artery, because it goes only to the left side of the colon. It arises from the forepart of the aorta, below the two emulgent arteries, *i. e.* pretty low down. It goes off rather from the left side of the aorta; it goes off very obliquely, and keeps close to the left side of the aorta for a great way; and when it has descended as low as the bifurcation of the aorta; it gives off its great branch to the left side of the colon, viz. the LEFT COLIC ARTERY; and then turning down over the iliac artery of the left side, it descends into the pelvis, along with the rectum, and ends there.

1. Its first branch is the ARTERIA COLICA SINISTRA. The lower mesenteric has run a considerable length, has passed as low as the bifurcation of the aorta, before this branch is given off. This artery soon divides into three large branches; the trunk itself is short and stumpy, the branches go off like those of the other side, at very acute angles: First, One branch ascends towards the angle of the colon, under which the spleen lies, and there divides itself into two branches; one keeping closer to the intestine, nourishes it; the other keeping more to the middle of the mesocolon, or broad membrane of the colon, meets the branch of the upper mesenteric, and completes with it the mesenteric arch, being

being indeed the larger and more important artery of the two. Secondly, Another branch goes directly across to the right side of the colon, and when it approaches the gut splits (as usual with the colic arteries, into two lesser branches, one turning upwards and the other downwards. Thirdly, The third branch of this left colic artery goes obliquely downwards to that part of the gut which lies in the hollow of the left haunch-bone, and which forms the turn named sigmoid flexure of the colon; and the membrane of the colon is here so fast braced down to the loins that this artery gives twigs to the loins inosculating with the lumbar arteries.

### 2. ARTERIÆ HÆMORRHOIDALES.

THE INTERNAL HÆMORRHOIDAL ARTERY is one of immense size; it is just the trunk of the lower mesenteric artery descending into the pelvis; it is often as large as a writing quill; it applies itself closely to the back part of the rectum; it arrives at it by turning in obliquely over the pelvis, and under the rectum, and passes down its whole length quite to the anus. It encircles the rectum completely on each side with its large branches, which meet again upon the forepart of the gut, and its branches lower down in the pelvis inosculate with the middle hemorrhoidal artery, and sometimes with those of the bladder and womb. This is the artery which prevents us from operating when a fistula in ano has gone deep by the back of the rectum; and which has given occasion to the establishing of something like a general rule in surgery, that one should not operate when

when the fistula is more than two or three inches deep. It is the last of the arteries belonging to the loose and floating viscera.

## Of the ARTERIES of the FIXED VISCERA of the ABDOMEN.

THE fixed viscera are, the capsulæ renales; the kidneys; the fat; and the testicles, which in the child lie within the abdomen. Of the arteries belonging to these parts, those of the kidney and testicle are the only regular ones.

### ARTERIÆ CAPSULARES.

THE capsulæ atrabiliariæ are two small bodies of a triangular form, of thick walls and small cavities, filled in general with a black and bilious-looking liquor. The ancients thought this the atrabilis, and named them the capsulæ atrabiliariæ: the moderns, from seeing them placed immediately above the kidney, and observing no apparent connection but with that gland, have named them capsulæ renales. They lie then above the kidney, are like the kidney surrounded with fat, have straggling arteries from various sources, but none regular nor important.

First, They have very generally some small branches from the phrenic arteries. These are the highest of the capsular arteries; they touch the uppermost point of this glandular-like but unknown body. They are named the upper CAPSULAR ARTERIES. Secondly, They often have small arteries from the aorta peculiar to themselves, which come off about the root of the

upper

upper mesenteric artery, go to the fat and glands, and play over the vena cava (at least those of the right side do), and go to the middle parts of the gland, whence they are named CAPSULARES MEDIÆ. Thirdly, they have their last arteries sent upwards to them from the emulgent artery, or artery of the kidney. They are named the lower CAPSULAR ARTERIES.

### ARTERIÆ RENALES.

THE two RENAL OF EMULGENT ARTERIES, the two arteries of the kidneys, go off from the sides of the aorta, midway betwixt the upper and lower mesenteric arteries. Each goes to its kidney almost at a right angle, arching a little over the bulging belly of the psoas muscle. The aorta is still a little inclined to the left side, and so the left emulgent is shorter, and mounts over its accompanying vein; while the right kidney, being further off from the aorta, and somewhat lower, on account of the liver being on that side, the right artery is longer, and is covered by its emulgent vein. When the emulgent artery, which is short and very thick, arrives at the concave edge of the kidney, it is divided into three or four large branches, which surround the pelvis, or beginning of the ureter, plunge into the substance of the kidney, and inosculate and make arches with each other. Then they, in supplying the kidney within its substance, form circles and arches over the roots of the papillæ uriniferæ, or secreting parts of the kidney, the vessels being thus distinct from the glandular part; the vascular part, being outermost, is called cortical; the secreting, being innermost, is named the tubular part.

Before

Before the emulgent arteries enter into the substance of the kidney to be thus distributed, they usually give off small arteries, as has been already mentioned, to the lower part of the capsula renalis, to the upper part of the ureter, and to the fat surrounding the kidney.

### ARTERIA SPERMATICA.

The spermatic artery, or artery of the testicle, is one of the most singular, both for its extreme smallness and great length, and for its important office. It arises on each side from the lateral parts of the aorta, a little above the lower mesenteric artery. The left spermatic artery rises somewhat higher, and often comes from the emulgent artery; it descends from the aorta almost in the same line with itself; it crosses the vena cava, and meets its accompanying vein upon the surface of the psoas muscle: it then forms the spermatic chord, and passes out through the abdominal ring; before it goes down into the testicle, it gives out many very small twigs. First, It gives small twigs to the fat of the kidneys; secondly, It gives small branches to the ureters; thirdly, Small twigs to the peritonem; and lastly, Small twigs to nourish the spermatic cord itself. When it has passed through the ring, it soon after divides into many small arteries for the several parts of the testicle, four or five in number; two of which go to the epidydimis, and two others, particularly large, go to the testicle; the largest of these branches turns round the testicle in a beautiful and serpentine form, waving along the upper part of the testicle, viz. just under the epidydimis, and sending beautiful coronary branches

down-

downwards all over the semicircle or convex surface of the testis.

These are the chief arteries, viz. those of the kidney and testicle. Those of the renal capsule I hold to be so irregular, that they hardly deserve the short description which I have given of them. The following classes of small and irregular arteries are equally insignificant; for few authors have been at the pains to enumerate the arteries going to the fat of the kidney; and none (except Murray) have been at the pains to gather together into one class or description the trifling arteries of the ureter.

### ARTERIÆ ADIPOSÆ.

THE ARTERIES of the FAT of the kidney are extremely small but numerous. The upper arteries come from the capsule and diaphragmatic arteries which are above the kidney; the middle arteries of the fat come from the renal artery itself, from the spermatic or even from the aorta; the lower arteries come from the colic arteries, and one from the spermatic, which comes off below the kidney, and turns up towards its lower end.

### ARTERIÆ URETERICÆ.

THE ARTERIES of the URETER, as it is a long canal, come off from various parts which it passes. Its upper arteries are from the renal artery itself, before it enters the kidney; and also from the capsulars and spermatics. The middle arteries of the ureter are more particular and more important: they arise either

from the aorta itself, or from the iliac artery, where the ureter crosses it; and they run far, both upwards and downwards, along the canal. The lowest arteries of the ureter arise from those of the bladder itself.

### ARTERIÆ LUMBARES.

THE LUMBAR ARTERIES are those which succeed to the intercostal arteries, and which run parallel with them; performing the same office in the loins which the intercostals do in the thorax, viz. nourishing the spine and the muscles.

The lumbar arteries arise from the sides of the abdominal aorta. The first arteries go off at right angles; the lower ones are a little inclined downwards. The right ones are longer, because they have to rise over the spine. The arteries of both sides, as soon as they have left the spine, sink under the psoas muscle, and go onwards behind it, round the side, till they terminate in the lateral muscles of the abdomen. The uppermost lumbar artery is large; and as it runs along the lowest rib but one, it of course gives arteries both to the transverse or innermost muscle of the belly, and also to the diaphragm, which indigitates with it in consequence of their both taking their origin from the same ribs. The two lower lumbar arteries are small, and begin to inosculate with the lesser arteries about the top of the pelvis.

Each lumbar artery gives out like each intercostal two chief arteries: 1. One which goes to the spine, and which, splitting into two, gives a larger twig to the vertebra itself; and a smaller one, which enters the

the sheath, traces the nerve backwards, and passes into the spinal marrow. 2. A muscular branch, which is also divided; for one branch of it supplies the psoas muscle, and then runs round within the muscles of the abdomen; while the other pierces the back, and supplies the sacro-lumbalis, longissimus dorsi, and other muscles of the loins.

## ARTERIES OF THE PELVIS.

The aorta divides into two great arteries, named iliac from their beginning in the loins. The two iliac arteries move downwards to the brim of the pelvis, where they meet the veins of the lower extremity ascending to form the cava, and also a vast plexus of lymphatics from the legs and pelvis, which twist round the arteries and veins. The two iliac veins lie upon the inner sides of the two arteries; and since these veins meet on the right side of the aorta to form the cava, of course the right iliac crosses the trunk of the cava. This bifurcation of the aorta is much higher than the pelvis; it begins upon the fourth vertebra of the loins, so that the abdominal aorta is in truth extremely short, and the iliac arteries go off at such an angle, that they diverge very gradually; so that when they arrive at the top of the pelvis, they are just over the joining of the haunch-bone with the sacrum: and it is but a very little below this again that they divide into their two great branches; the one named the external iliac, which passes straight



forwards

forwards into the thigh; the other, the internal iliac, which dives immediately down into the pelvis to supply the internal parts; and this is the artery which must be first described.

### ARTERIA SACRA MEDIA.

This bifurcation of the aorta gives off just one artery, which proceeds exactly from the fork; and being in the middle, it is a single or azygous artery, which has not a fellow. It is small, long, very regular, and passes down so correctly in the middle of the bone, that it is named the MIDDLE SACRAL ARTERY. It is about the size of a crow-quill; passes directly over the middle of that projecting point which is named the promontory of the sacrum; it descends expressly in the middle of the bone, quite to the point of the os coccygis. At the place of each vertebra (for the sacrum consists of vertebræ now united together), it gives off cross branches, which go across the body of the sacrum to inosculate with the lateral sacral arteries. Besides these, it gives arteries to the substance of the bone, and not unfrequently small arteries to the rectum. This artery ends near the point of the os coccygis in a forked or double inosculation with the lateral sacral arteries of each side.

### ILIACA INTERNA.

The INTERNAL ILIAC ARTERY is of vast size; it not only supplies all the parts within the pelvis, but sends out by the several openings of the pelvis those great arteries which supply both the private parts, and the immense mass of muscle which surrounds the haunch.

haunch. Thence the necessity and the usefulness of arranging them under two classes: First, Of the lesser arteries which go to parts within the pelvis, as to the loins, to the sacrum, to the bladder, and to the womb; and secondly, Those infinitely larger arteries which go out through the several openings of the pelvis, and go to the hips, the haunch, and the private parts.

This artery we cannot describe in the adult, without attending to its condition and function in the child; for it is that indeed which gives it the peculiar form which we have to describe; and which especially gives it that arch downwards, from the convexity of which all the great branches go off. For in the child, the internal iliac or hypogastric artery is extremely large: First it turns down into the pelvis with a large circle; then it goes close to the side of the bladder very low into the pelvis then it begins to rise again by the side of the bladder, out of the pelvis, and going along by the urachus (which is a tube or ligament rather leading upwards from the bottom of the bladder), it goes out by the navel, forming the umbilical artery. Now this sudden turn by the side of the bladder makes the artery convex downwards, i. e. towards the parts which it has to supply. The artery keeps this same form in the adult; both in the child and in the adult all the great branches come off from the back of this arch.

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## ORDER FIRST.

The branches of the hypogastric or internal iliac artery, which remain within the pelvis.

### 1. ILEO-LUMBALIS.

THIS artery is so named, because it so resembles the lumbar arteries that it might be mistaken for the last of them; and because it belongs equally to the haunch-bone and to the loins. It goes off from the outer side of the iliac artery, about an inch below the bifurcation; it is about the size of the lumbar arteries, or a little larger; it turns in behind the iliac artery, and passes under the psoas muscle; its trunk is short, for it splits immediately into its iliac and lumbar branches. The lumbar branch goes off betwixt the last vertebra of the loins and the inner end of the ilium, and goes directly upwards; it gives its branches about the psoas muscle. The iliac branch setting off from the same point, runs straight outwards, lodges itself under the edge or crista ilii, aad supplies the iliacus internus muscle by a superficial branch; and it nourishes the bone by a deeper branch, which lies close in the hollow of the haunch.

### 2. ARTERIÆ SACRÆ LATERALES.

THE LATERAL ARTERIES of the SACRUM are very generally three or four in number. Sometimes we find one general artery coming off from the iliac, or from the ileo-lumbar artery, running down all the side of the sacrum, and giving off the lateral sacral arteries; but much more frequently we find three distinct arteries coming off from the sides of the iliac artery, which run across the sacrum in the following manner, to inosculate with the middle sacral artery: First, Each lateral sacral artery has one large branch, which

which runs along the forepart of the sacrum, runs along the naked bone, and inosculates with the middle sacral artery: Secondly, Another branch, still larger, dives into each of the sacral holes, which not only nourishes the nerves, and the sheath of the cauda equina, and the bone itself by one branch, but penetrates by another branch through the posterior sacral hole, and supplies the periosteum, the great ligaments which join the ilium to the sacrum, and the root also of the sacro-lumbalis, and glutæal muscles. From these two branches (viz. to the spine and to the posterior muscles), and from the regularity of these five arteries (going from some artery or other into each sacral hole), they may be resembled to the intercostal and lumbar arteries, to whose office and plan they have succeeded.

## ARTERIA HYPOGASTRICA.

The hypogastric artery is the umbilical artery, of great size and importance in the child; and even in the adult it still remains, in this sense at least, that though the forepart of it (where it turns up by the side of the bladder) is closed, even that part is still known by a round ligamentous substance, into which it is converted, which we easily trace up to the navel, where the artery meets its fellow of the other side.

This artery is even in the adult body pervious down to the side of the bladder, where in Man it gives one long and slender artery, sometimes two, which go to the sides of the bladder; and in Women, small arte-

ries to the womb, sometimes to the rectum; but these branches are quite irregular in number and size.

### ARTERIÆ VESICALES.

THE ARTERIES of the BLADDER are extremely irregular both in number and size; for it is to be considered, that the bladder being a round body placed amidst great arteries, and being itself membranous, and needing but few or but small branches, it gets them from various sources. Very generally the hypogastric, just before it closes into a ligament, sends one or more small arteries downwards and forwards to the neck of the bladder, at that part where the vesiculæ seminales lie; and of course the vesiculæ and the prostate gland get small twigs from this artery of the bladder; sometimes also the bulb of the urethra has a small artery from it.

### ARTERIÆ HÆMORRHOIDALES.

THE arteries of the rectum are all named hæmorrhoidal arteries. The upper hæmorrhoidal artery is the great branch of the lower mesenteric continued to the pelvis. The middle hæmorrhoidal artery is one which sometimes comes from the hypogastricartery, but very often from the pudic artery, insomuch as to be reckoned among its regular branches. The lower, or the external hæmorrhoidal artery, almost always is a branch of the pudic artery, or that artery which goes to the penis. Two great arteries, one going to the rectum and another to the womb, are the last which the hypogastric gives off before it degenerates into a ligament.

ARTERIA

## ARTERIA HÆMORRHOIDEA MEDIA.

The middle hæmorrhoidal artery is not a large branch. Often we do not find it, but other arteries supplying its place; sometimes again it is so large as to give off both the uterine and the lateral sacral arteries; but in general it is small. It comes off from the hypogastric opposite to the glutæal artery (presently to be described); it touches the rectum below its middle, and descends curling and winding chiefly along its forepart quite to the anus; and often it gives, as it runs betwixt the rectum and bladder, arteries to the bladder, prostate gland, and vesiculæ seminales. It is this artery also which in Women gives small branches to the vagina.

## ARTERIA UTERINA.

The womb has four arteries, two from each side; the uppermost that which enters by the upper corners of the womb, comes from the aorta, corresponds with the spermatic in Man, runs along the broad ligament towards the ovaria. The lower artery of the womb, and the largest, comes from the hypogastric, enters the womb, where it is connected with the vagina, and runs upwards along the sides of the womb to meet the spermatic; and it sends also at the same time branches downwards into the vagina, and forwards upon the bladder, where it adheres to this part of the womb.

This uterine artery arises from the hypogastric beside the origin of the hæmorrhoidal artery, and when it enters the womb it becomes very tortuous.

These,

These, then, are the chief arteries of the rectum, bladder, womb, vesiculæ seminales, and other parts within the pelvis.

## ORDER SECOND.

### OF THE ARTERIES WHICH GO OUT FROM THE PELVIS TO THE HAUNCHES, HIPS, AND PRIVATE PARTS.

In this second class or order there are just four great arteries; one which goes over the back of the haunch-bone to the glutæal muscle, named Glutæal artery; one going downwards over the tuber ischii to the hip, named the Ischiadic artery; one which goes out of the pelvis, returns into it again, and passes out a second time by the root of the penis, named the Pudic artery; and one which passes out through the thyroid hole into the deep muscles at the top of the thigh, named Thyroid artery. All these larger arteries go off from the convex of that arch which the hypogastric forms, and move backwards and downwards, in order to escape from the pelvis, either by the sciatic notch or below.

Let it be remembered, that the iliac artery forks just at the meeting of the ilium and sacrum; that the great sacro-sciatic notch is formed by this joining of the ilium and sacrum, and is just under the junction of these two bones: that the glutæal artery passes out by this sacro-sciatic hole; and that of course it is the first, as well as the greatest, of those three arteries which turn backwards out of the pelvis.

### ARTERIA GLUTÆA.

THE GLUTÆAL ARTERY goes off from the internal iliac immediately after the lateral sacral arteries. It is exceedingly large, thick, and short, within the pelvis, for it immediately turns over the bone the turn which it makes over the naked bone is backwards and upwards; it instantly divides itself into a great lash of vessels, which spread in every direction, supply the two glutæal muscles, and turn and ramify upon the back of the haunch-bone, just as the great scapular arteries play over the surface of the scapula.

The pyriform muscle goes out from the pelvis at the same great opening with the glutæal artery, and the artery is further accompanied by the great sciatic nerve; they pass together over the pyriform muscle betwixt it and the bone; and when the glutæal artery is to give out its branches, it splits into two great branches at the edge of the glutæus medius muscle. By this splitting the glutæal artery is arranged thus: First, One great branch passes under the glutæus medius, of consequence it is naked upon the back of the ilium; it sends one large and beautiful artery, which courses round the bone according to the line of the crista ilii, which supplies all the upper half of the haunch-bone with its nutritious arteries, and supplies of course all the upper half of the great or outermost glutæal muscle where it arises from the spine and dorsum of the ilium. Another large branch, still belonging to this deeper artery, passes under the thickest part of the belly of the glutæus medius, lies upon the small fan-like muscle named

named glutæus minimus, and gives innumerable great branches to the middle and lesser glutæi muscles, and to the joint of the thigh-bone.

The other great branch of the glutæal artery slips in betwixt the glutæus major and the glutæus medius; and as it lies betwixt these two great muscles, it gives a prodigious number of branches to each, but chiefly to the great glutæal muscle.

### ARTERIA ISCHIADICA.

THE SCIATIC ARTERY is so named, because, instead of going upwards with this crooked turn towards the haunch, it goes obliquely downwards to the hip, in the direction of the main artery from which it comes. It comes off from the iliac about an inch lower than the glutæal, and is next to it in size; almost equal when (as it often happens) the pudic artery is derived from it. The glntæal artery should be contrasted with it thus: The glutæal goes out above the pyriform muscle; the sciatic goes out below it; the glutæal turns upwards over the haunch-bone, the sciatic turns downwards along the hip; the glutæal spreads its arteries wide with sudden and crooked angles; the sciatic sends its arteries downwards in a gentle waving form, or almost straight; and so numerous as to be compared with a lash of many thongs proceeding from one shaft.

Often the glutæal artery, before it passes out of the pelvis, gives small twigs to the rectum, to the bone, and to the pyriform muscle; and in like manner the ischiadic, before it escapes from the pelvis, gives also trivial

trivial branches to the rectum, and to the pyramidal muscle.

The branches of so great an artery, ramifying merely among muscles, and among such a vast variety of muscles, can neither be named, nor are worth naming. All that is to be desired is, to know the trunk, and the general direction in which its greater branches go. Among these branches there are few remarkable.

First, The COCCYGEAL ARTERY turns quick backwards upon the sciatic ligaments, and lying under the glutæus magnus; and passing along by the direction of the ligament, it arises at that part of the sacrum whence the ligament takes its rise; and turning downwards upon the coccyx, and upwards upon the back of the sacrum, it inosculates with the sacral arteries through the posterior holes.—Secondly, Another branch, more remarkable for its office than its size, runs downwards along the sciatic nerve, supplying its coats and substance.—But the great branch of this artery sends a confused lash of arteries downwards, which give arteries, first to the glutæal muscles and pyriformis, and then downwards to all those muscles of the back of the thigh which arise about the knob or tuber of the ischium. In short, all its chief branches are muscular; and the artery is remarkable for no other peculiarity than this, that its inosculations downwards with the reflected arteries of the thigh are so frequent, that these alone may save the limb in wounds of the femoral artery above its profunda, or that great branch which belongs to the thigh.

ARTERIA

## ARTERIA PUDICA COMMUNIS.

The common pudic artery*, or the artery of the external parts of generation, is the third great artery which goes out from the pelvis backwards. And there is in the course of this artery a peculiarity which is never fully explained; and being unexplained, makes the succeeding description quite defective and lame: and it is this. The pudic artery (which is nearly of the size of a writing quill) usually comes off as a branch from the sciatic artery; it goes out from the pelvis along with the sciatic artery through the lower part of the sciatic notch, under the lower edge of the pyriform muscle, over the upper sacro-sciatic ligament. But no sooner has it made its appearance along with the sciatic artery, and emerged from the pelvis, than it returns into the pelvis again; it does not go over the outside of the tuber ischii, and so down to the perinæum; but it just appears out of the pelvis, rises over the upper sacro-sciatic ligament, gives out a few branches, turns in again under the lower sacro-sciatic ligament, or rather under the spine or sharp point of the ischium, whence that ligament arises: it is now within the pelvis again; it lies flat against the inner surface of the ischium; it runs along by the direction of that bone till it approaches the symphysis pubis, where the root of the penis is. It there dives into the root of the penis, having just

* It is named often the circumflex pudic artery, the internal pudic artery, the middle pudic artery, the great pudic artery.

before

before given off that branch which goes to the perinæum. It is this long artery, running naked and unprotected along the whole inner side of the ischium, bending as the arch of the ischium and pubis bends, that is cut by ignorant lithotomists, which a broad gorget is sure to wound, and which can be safe only by our exchanging the gorget for the knife.

The branches of the pudic artery are chiefly these:—First, Before it proceeds out of the pelvis, it usually sends branches inwards to the neck of the bladder, vesiculæ seminales, and prostate gland:—Secondly, When it emerges from the pelvis, and while bending over the sacro-sciatic ligament, it gives, like the sciatic artery, chiefly muscular branches; it gives twigs to the sacro-sciatic ligament and pyriform muscle; others go to the gemini muscles, and turn over them to the great trochanter, and to the hip-joint, reaching as far as the acetabulum; others spread over the tuber ischii, to which they give arteries, which go outwards along the three muscles of the thigh which arise from this point; and it sends inwards from this part an artery which encircles the verge of the anus, and belongs to the sphincter and levator ani muscles. This branch is named the LOWER OR EXTERNAL HÆMORRHOIDAL ARTERY: and other branches it sends forwards into the perinæum; but these are smaller and less regular arteries; they are not what are distinguished by the peculiar name of perinæal arteries. This artery, like the ischiadic, ends every where in inosculations with the reflected arteries of the thigh.

Thirdly, The artery returning again into the pelvis, and running along under the flat internal surface of the

the ischium, gives off many small branches to the bladder, prostate gland, vesiculæ seminales, and rectum. But when it has reached the perinæum, and is about to emerge from the pelvis a second time, and go into the root of the penis, it gives out three chief arteries; one to the perinæum, one to the body of the penis, one to the back of the penis thus:

When the artery has approached nearly to the musculus transversalis perinæi, it splits into two branches; one of which is the artery of the perinæum, the other is the proper artery of the penis.

ARTERIA PERINÆI.

THE ARTERY of the PERINÆUM passes under the transversalis perinæi, and betwixt the accelerator and erector penis; in short, it comes out from that triangular cavity which we cut into in lithotomy; in which operation ofcourse this branch cannot escape. The artery having escaped from this triangular cavity, runs forwards along the perinæum for two or three inches, according to the size of the subject, growing very sensibly smaller as it goes along. It is chiefly for supplying the skin and muscles of the perinæum; and gives these branches: 1. When it has just come out from the triangular hollow, it gives off from its root one branch at right angles, which goes directly across the perinæum; it keeps the course of the transverse muscle; it may be named ARTERIA TRANSVERSALIS PERINÆI, and ends, about the sphincter ani. 2. It gives branches to the accelerator and erector muscles. 3. It gives branches to the scrotum; and being continued along the corpus cavernosum of each side, it ends upon the tendinous sheath,

sheath, which binds the corpora cavernosa. Thus ends the perinæal artery.

ARTERIA PENIS.

THE PROPER ARTERY of the PENIS is the continued trunk of the pudic artery. It is much larger than this perinæal branch; is as big as a crow quill; it keeps still close to the bone, while the perinæal artery goes outwards; it at last touches the symphysis pubis, and of course pierces the corpus cavernosum, just where it takes its rise from the leg of the pubis: and here it splits into two great branches; one to the corpus cavernosum, and one to the back of the penis, or rather into three, since there is one also for the bulb of the urethra.

The bulb of the urethra is quite insulated in the perinæum, while the corpora cavernosa arise from the bone. Now, first, as the artery of the penis is pasting by the side of the bulb, it gives off an artery to the bulb sidewise, which in part plunges into the bulbous substance, and in part is scattered upon the accelerator, prostate gland, &c.

Secondly. The artery having risen to the place where the root of the corpus cavernosum is, gives off that artery, which runs small and delicate along all the back of the penis, till it ends at last in a branch which encircles the corona glandis. This is named the arteria dorsalis penis.

Thirdly, The artery now plunges deep into the proper substance of the penis; the artery of each side goes into each corpus cavernosum at its root, and splits into two branches; these run chiefly along the septum, or partition betwixt the corpora cavernosa of each side.

It is this artery which pours out blood so freely into the cells of the penis, and causes erection.

These three, the glutæal, the sciatic, and the pudic arteries, are the only ones which go out from the pelvis behind, and one only goes out by an opening on its forepart, viz. the obturator artery.

### ARTERIA OBTURATORIA.

THE OBTURATOR ARTERY is so named from its passing through the thyroid hole. No artery is less regular in its origin; arising sometimes from the Iliac, sometimes from the Hypogastric, and not unfrequently from the root of the Epigastric artery: in which case it turns back again over the pubis, coming into the pelvis through the ring. But no artery is more regular in its destination; a large artery always passes through the thyroid hole; the thick muscles in the centre of the thigh cannot want it.

The obturator artery, arising from the iliac or hypogastric, runs along by the upper edge of the pelvis, by the lower edge of the psoas muscle, accompanied with the obturator nerve, which is to go through the hole along with it. Having arrived at the forepart of the pelvis, it slips through the oval hole by a very small opening, which is in the upper part of the tendinous membrane, which closes that hole, and which is consequently at the upper edge of the obturator internus muscles. The artery, before it passes out of the pelvis, often gives branches of considerable side downwards to the neck of the bladder, prostate gland, and vesiculæ; to the iliacus internus and psoas muscles, and to the lymphatic glands which lie upon them;

and

and there is always a branch, which encircles the upper part of the foramen thyroideum, lies close upon the bone, and gives its twigs upwards into the muscles of the belly.

After the artery has passed along with its nerve through the thyroid hole, it comes into the very heart or central part of the thigh. Almost all its branches are muscular; none are worth distinguishing by name; it is only the general tendency of the artery that needs to be explained. It divides into two chief branches, taking opposite directions. The first is deeper; it turns downwards and outwards towards the hip-joint. It performs three services here; it gives first arteries to the periosteum, to the capsule, and to the gland within the acetabulum; it gives also large branches to the obturator quadratus femoris, and all the great muscles which immediately surround the joint; it also forms very large and important anastomoses round the joint, with the sciatic and pudic arteries from the pelvis, and with the reflected arteries from the thigh.

The more superficial branch of the thyroid sends all its branches into the great muscles upon the inner side of the thigh coming from the pubis. Its chief branches are to the upper part of the triceps muscle; it sometimes gives branches even to the superficial muscles, as the gracilis and sartorius; always, at least small twigs pass through these muscles to the skin of the thigh and to the scrotum. Of these two arteries, this superficial one encircles the inner edge of the thyroid hole, or that which is next the pubis, with one of its branches; while the deeper artery encircles

the outer edge, or that which is next to the hip-joint, so that they meet upon the bone inosculating with each other.

## CHAP. IV.

## ARTERIES OF THE LOWER EXTREMITY.

### ILIACA EXTERNA.

THE EXTERNAL ILIAC ARTERY is that branch of the common iliac which descends under Poupart's ligament into the thigh. The internal iliac or artery of the pelvis parts from this within the pelvis at the joining of the ilium and sacrum. The external iliac passes down into the thigh, by bending along the upper edge or brim of the pelvis, directed by the lower edge of the psoas muscle, which also descends into the thigh. This great artery is accompanied by the anterior crural nerve; its corresponding vein lies by the side of it; the lymphatics of the thigh creep upwards along this artery into the pelvis; and when the artery descends into the thigh, it passes so over the bulging part of the acetabulum and head of the thigh-bone, that it is felt projecting there and beating with amazing force.

The

The projection by which the artery is thus thrown forwards is not merely the naked pelvis and the head of the femur; these parts are covered by the flesh and tendons of the psoas magnus and iliacus internus, which also come out from the pelvis to the thigh. The artery lies cushioned upon these muscles; the muscles dive very deep to get at the trochanter minor or posterior trochanter of the thigh-bone. The artery follows them; and thus it is plunged as it were into a deep cavity, assumes a new position, and this constitutes a second point of description.

The hollow in which the artery now lies may be compared with that of the bend of the arm. The artery now takes the name of femoral, lies deep in a hollow, surrounded by much fat and many glands; the cavity is covered with a very strong fascia, or tendinous sheath, which descends from the muscles of the belly over Poupart's ligament, and which is greatly strengthened at this point by the general fascia of the thigh. Here the femoral artery, instead of sending off less effectual branches from point to point as it moves downwards, and which could not have conveniently penetrated through all the thickness of the thigh, sends off one great branch, which furnishes all the thigh without exception, whence it is named the muscular artery of the thigh. This great artery goes off from the femoral just like the ulnar from the artery at the bend of the arm, *i. e.* very deep among the muscles, in the triangular cavity above described. Thence it is oftener named profunda than muscular artery.

The femoral artery having sent down this great branch, equal almost to itself in size, inclines out-

 wards

wards again, meets the inclined line of the sartorius and follows its oblique direction, assuming a new character; for now it becomes a second time quite superficial, is covered by nothing besides the strong fascia of the thigh and by the skin. It is felt beating along the line of the sartorius muscle; and by that line we apply the cushion of our tourniquet. It retires from our feeling only about two hands breadth, or a little more, above the joint of the knee; at which place it perforates the triceps or great muscle of the thigh, gets from the fore to the back part, or, in other words, forsakes the thigh to go down behind into the ham, where it exchanges its name for that of popliteal artery.

The popliteal artery, when it has got into the ham, meets with its corresponding nerve, which is of vast size; and the artery lies now flat upon the back part of the thigh-bone, passes down in a hollow formed betwixt its great condyles, lies flat upon all the back of the knee-joint, is enclosed by the two great hamstring muscles from above, and by the two great heads of the gastrocnemii muscles below. But although we say it is protected, yet in truth it is not tightly bound down by a fascia embracing it, but lies on the contrary so loose and unsupported among the cellular substance, that we have the most certain evidence of its being often racked and strained in sudden or awkward motions of the joint.

From the ham the artery descends into the leg, under the heads of the gastrocnemii muscles; and being lodged behind the great bulging, or head of the tibia, below the joint, it there divides into three great arte-

ries.

ries. One passing down behind the tibia is named posterior tibial artery; one perforating the interosseus membrane goes down along the fore part of the tibia, is named tibialis antica; the third artery, passing down behind the fibula, is named the fibular or peronæal artery. These may be justly compared with the three arteries of the forearm; and as those meet in arches upon the palm of the hand, these meet and form similar arches on the sole of the foot.

Even from this slight and general description of this important artery, many conclusions may be deduced not indifferent to the surgeon; for there are several points in the course of this artery very peculiarly marked.

First, It is thrown so forwards by the bulging of the pubis, where it forms the socket for the thigh-bone, it beats so strongly just under the rim of the belly, that we cannot, at least till we try, doubt of its being easily compressed. I see, indeed, that Acrel, in very desperate circumstances, when his ligatures had given way even before his eyes, and the arteries burst, and after the surgeons had been twice deluged with the blood of the femoral artery, thought that he had suppressed this artery, by resting on it with his thumbs. But indeed the poor patient, under these horrible circumstances, as Acrel justly calls them, must have fallen so faint and low, by a tedious alarming operation, and by the repeated bleedings, that any thing might have suppressed the pulse in the femoral artery, when that of the heart itself was well nigh gone.

gone*. But this is one of the points in which it is the most necessary for every man to speak from his own experience. I have tried it in the most favourable circumstances in a slender young man; and when I thought myself sure of the point, behold the blood gushed out with a whizzing noise and prodigious force. I have seen others try it, and fail. It is perhaps not impossible to compress the femoral artery; but it is not an easy thing, and is an expedient never to be trusted where the life of a fellow-creature is immediately in danger.—Secondly, The strong covering of the fascia gives a peculiar form to the aneurism of the thigh; it keeps it flat, forces the blood to spread abroad into the surrounding parts; and this deep driving of the blood among the muscles, together with the great size of the sac, and the putrefaction of three or four pounds of blood, causes that gangrenous and sloughing condition of the parts, by which we are so often foiled in our best concerted operations, and after the artery has been well and fairly tied.—Thirdly, It is very obvious that the profunda might with more propriety be named the femoral artery, since it is the proper artery of the thigh; and though Heister, and some of the best among the old surgeons, spoke of this division as one which only sometimes took place, we know that a leg could no more be without a profunda than without what we call the femoral artery; and

* "His in horrendis angustiis, cum nec nova ligatura, nec torcularis contractione hæmorrhagia sisti posset, in trunco ipso, dum ex inguine prolabitur, pollicibus firmiter admotis, compressionem instituere placuit, quo effluxus substitit."

we

we also perceive, notwithstanding the doubts and fears of some modern surgeons, that when the femoral artery is wounded, it is after all only a wound of the artery of the leg.——Fourthly, The large branches which the profunda sends upwards round the haunch, inosculating with the sciatic and pudic arteries, and the branches which it sends downwards to the knee, inosculating round that joint with the arteries of the leg, make this branch of peculiar importance to the surgeon; for when the artery is wounded in the groin, above the profunda, this branch saves the thigh, by its inosculations round the haunch; and when the artery is wounded in the thigh, below the profunda, or in the ham, it saves the leg by its inosculations round the knee; and when the whole line of the femoral artery has been obliterated, it has saved the whole extremity, as I have elsewhere proved, by receiving the blood from the arteries round the haunch, and conveying it down to the arteries below the knee, being thus an intermedium betwixt the internal iliac artery and the arteries of the leg, capable of forming a new line of circulation behind the thigh when that before is shut up. Nor should it be forgotten, that the aneurism on the forepart of the thigh may be from the profunda; and then the femoral artery which lies before it may be cut across by a rash or ignorant surgeon.

Fifthly, The place of the femoral artery passing through the triceps muscle is next to be observed, for these reasons. At that point it lies close upon the bone; and as this happens exactly at that distance above the knee at which we usually amputate, we expect in such

such amputations to find the great artery close by the bone. As the artery is at this point tied down by the tendon of the triceps, and is in fact passing through a tendinous ring, it sometimes happens that when we have cut near this, but not upon it, the flesh shrinks in such a way that even this great artery, though it bleeds, is not easily found; but one stroke of the scalpel, running along the bone, cuts the tendon up, and exposes the artery with open mouth.——This single point makes all the difference betwixt an aneurism of the thigh and of the ham; it is peculiarly necessary to mark this, in order to ascertain the extent of the disease before beginning an operation. Nothing can have a worse appearance than that which has actually happened, viz. a surgeon beginning that operation in the ham, which he should have attempted rather on the forepart of the thigh; and being forced to change his ground, and to begin a second operation on the forepart of the thigh, or, what is worse, to cut up the tendon, and follow the diseased artery to the forepart of the thigh, cutting, in short, first longitudinally betwixt the hamstrings, and, after an hour's working perhaps, cutting crosswise to reach the forepart of the thigh.

6thly, Is it not a matter of very high importance to study the ham still more carefully than the axilla, since the artery is so often hurt at this place by rude motions of the joint? For it is a narrow cavity; the artery lies close upon the joint and bones; and when it is allowed to remain long in a diseased state, enlarging and dilating the ham, we perform in the end a hopeless operation; or, if we had hopes when we began

gan our operation, they are all over before it is ended: for the parts are found to be diseased, the bones carious, the joint spoiled; there is no hopes even of present safety, and of the ligature holding, and much less any expectation of a permanent cure. Often the greatest surgeons have been contented to finish such an operation by cutting off the limb!

7thly, When the artery has gone down beyond the ham, and seems lodged safely under the gastrocnemii muscles, still it is not safe; it is bended tense over the back of the joint; it is pressed by the gastrocnemii stretching over it; and their violent action has often been such, as to have torn the artery with a tumour so immediate, and with such excruciating pain, that the surgeon has been constrained in a manner to cut off the limb even upon the spot.

8thly, Very often we are obliged to decide, whether a tumour of the thigh or a tumour of the ham can be cut away only by our knowledge of these arteries. How often the anterior arteries of the leg are cut by workmen, and how much they are exposed to the stroke of the adze or axe, every practical surgeon must know: but the mischances that open arteries are quite unthought of. I have known a man standing carelessly by his scythe, which was set upright, the blade along the ground, and the shaft resting upon his arm, cut the artery behind the outer ankle so as to form (when the wound healed) a large, livid, and strong beating aneurism, ready to burst, and requiring immediate operation.

The epigastric artery is in danger in operations for hernia. The femoral artery is the subject of frequent

operations;

operations; the popliteal aneurism is a disease of this artery in the ham; and even the simple operation of amputating either the limb itself, or tumours in the thigh or ham, requires a perfect knowledge of all these arteries.

But although no formal operation affected these lesser arteries, yet the main artery itself is so exposed, and so superficial where it runs down the thigh, that it is wounded in a hundred various ways. It is very singular how often it has been wounded by one particular accident, viz. the dropping of a pair of scissars, and with a sudden instinctive effort clapping the knees together to catch them. It has been wounded once or twice by a shoemaker clapping his knees thus together to catch his sharp-pointed paring-knife. One of my pupils lay three months in London, uncertain whether his femoral artery was wounded; for he had in this way catched his pen-knife, the point of which had run into his thigh, and wounded some great artery. It has been cut across by balls; it has been wounded even by a single slug; it has been uncovered by wounds which yet did not touch its coats, and has in consequence dilated into an aneurism. I have known a boy stab another with a pen-knife in the thigh, and strike so critically as to open the artery with a wound like that of a lancet. My friend Mr. Harkness gave me the privilege of dissecting an aneurismal limb which he was obliged to cut off; and in which the artery was (if I may use such an expression) broken or torn across the upper end of the thigh-bone, which had been broken by a fall about three weeks before.

All

All these accidents must come upon the surgeon very suddenly; and if they come upon him unprepared, all is in a moment lost. I once saw a fine young fellow die from this alarm of the attendants and confusion of the surgeon. He was a tall, stout, young man, who was sitting at table with his companions eating bread and cheese, taking his glass, and telling his tale. He had in his hand a sharp pointed table knife, which he happened to hold dagger-wise in his hand, and in the height of some assertion or oath he meant to strike the table, but the point missed, and slented over the table; he had stabbed himself in the femoral artery, and with one gush of blood he fell to the ground. When I came, I found the young man stretched out upon the floor; he was just uttering his last groan; the floor was deluged, all slippery, and swimming with blood. The wound was covered with a confused bundle of clothes, which I instantly whirled off; and in that moment two gentlemen, who had been first called, and who had both run off for tourniquets (because tourniquets are used to stop bleedings), returned; and had the unhappiness to see that the hole was no bigger than what I could close, and had actually shut up with the point of my thumb; and which, had it been shut and put together with a good compress, would have healed in three days, forming a large beaten aneurism within, allowing time for a deliberate operation.

In short to enumerate the variety of accidents which may affect this artery would be impossible; but surely from the little that I dare venture to say in this place, it must seem one of the largest, the most exposed,

exposed, and most dangerous, and by all this the most important, artery in the body; and from these previous hints and general descriptions, the value of the several branches which are now to be enumerated will be more easily felt and understood.

## BRANCHES OF THE FEMORAL ARTERY.

### ABOVE THE GROIN.

THE FEMORAL ARTERY above the groin, that is, just before it passes from under the socro-sciatic ligament, gives off two very singular arteries, which turn backwards and never appear in the thigh; the one, going upon the forepart of the belly on the inner side, is the epigastric artery; the other, turning backwards along the inner surface of the haunch-bone, is named circumflexa ilicum.

### ARTERIA EPIGASTRICA.

THE EPIGASTRIC ARTERY, so named from its running up along the belly, goes off from the inner side of the femoral artery about an inch before it passes out into the thigh.

The epigastric, when first given off, turns downwards with a full round turn till it touches Poupart's ligament. The peculiarity of its course here must be very carefully attended to. The femoral artery lies at the very outer margin * of the opening, called the crural arch. The Fallopian ligament forms the upper

* Viz. that end of the slit or arch which is nearest to the haunch-bone.

line

line of the crural arch. The epigastric artery moves inwards and downwards with the Fallopian ligament, running along its lower edge; then it crosses the opening called the abdominal ring, behind the ring, and also behind the spermatic cord which passes through the ring; then it mounts by the border of the transverse muscle, and gets to the rectus muscle of the belly; but it is pretty high before it touches the side of the rectus, and lying on the outside of the peritoneum, and on the inner surface of the rectus muscle, and keeping in the direct line of the rectus muscle near its centre, or rather nearer the outer edge of the muscle, and inclining inwards, it mounts from the groin to a little below the borders of the thorax, when it inosculates very freely with the internal mammary artery. These are the inosculations which were mentioned page 346. Through its whole course this artery is so large as to make its wounds important: we should know where to stop it in wounds; we should remember to avoid it in opening or extirpating tumours. I have seen some confusion and much loss of time during an operation from not attending to this. The main artery must be remembered; its branches are of little value. The only branches which it is at all necessary to mention are, first, one small twig, which it sends downwards along the spermatic cord; soon after entering under the abdominal muscle, it gives off a large branch almost equal to the artery itself, which goes directly towards the navel, and ends there. This branch goes obliquely across the muscle, while the main artery follows the general line of the muscle, and gives branches on

every

every side to the rectus, transversalis, obliquus; in short to all the muscles of the abdomen, and spreads its last branches very freely about the lower border of the chest.

### ARTERIA CIRCUMFLEXA ILEUM.

THE CIRCUMFLEX ARTERY of the HAUNCH is named CIRCUMFLEXA from its turning directly backwards, and ILEUM from its passing along the hollow of the haunch-bone.

It is smaller than a crow-quill; it goes off from the outside of the femoral artery opposite to the epigrastic, or rather a little lower; exactly at that point where the outer end of the Fallopian ligament begins in the haunch-bone. It runs backwards in a curved line along the hollow of the haunch-bone, curving along with the crista ilii, or ridge of the ilium, under which it lies. Its line is along the most naked part of the bone, where the internal iliac muscle begins on one hand, and the transverse muscle of the belly on the other; in short, it runs along all the upper edge of the internal iliac muscle, quite round almost to the lumbar spine, where it joins the ileo-lumbar artery by small inosculations; for at this place the reflected iliac artery, which grows gradually and sensibly smaller, is almost spent. There are no remarkable branches which deserve to be described or even to be named, unless it be one which goes off early, near the head of Poupart's ligament, and gives branches to the ligament, to the sartorius muscle which arises at the same point of the haunch-bone, and to the edge of the iliac muscle. And as it runs along

along betwixt the iliac muscle on theone hand, and the transverse of the belly on the other, it gives many branches downwards to the internal iliac and psoas muscles, and to the substance of the bone; and upwards it gives three or four branches into the abdominal muscles, which go so far along the belly as to inosculate with all its other arteries.

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## BELOW THE GROIN.

These last branches, viz. the epigastric and reflected iliac arteries, I ascribe to the internal iliac; for the artery is still within the abdomen, or at least not without the arch of the thigh.

The femoral artery, until it gets down into the hollow which I have described, gives no branches, or none with which I would choose to confound the description of the profunda or great artery of the thigh. The branches which the femoral gives off before that are only small twigs to the fat, glands, skin, or private parts; but one or two of those to the private parts are sometimes large.—First, Twigs go out along the femoral ligament, and terminates in the skin.—Secondly, Twigs go to the fat, and lymphatic glands of the groin.—Thirdly, There ascends a small branch, sometimes towards the origin of the sartorius, to the middle glutæal muscles, and to the beginning of the fascia lata.—Fourthly, Of those branches which go across the upper part of the thigh to the genitals, and which are named PUDICÆ EXTERNÆ to distinguish

their branches from those of the pudica communis, there are usually three. The uppermost is scattered about the fat of the pubis. The middle one goes across the heads of the triceps; it is longer and larger than the others; it goes to the side of the scrotum and penis in Men; in Women it is large, and runs into the labium pudendi. The lower one of the three goes to the lower parts of the scrotum, and to the skin of the thigh near it.

### ARTERIA PROFUNDA FEMORIS.

THEN comes off the profunda femoris, the DEEP or MUSCULAR ARTERY of the THIGH. It arises from the femoral artery about four inches below the groin, more or less according to the size of the subject. It turns off from the femoral artery with a bulging, which looks backwards and towards the outside of the thigh. It lies deep in the triangular cavity, upon the face of the iliacus internus and pectinalis muscles. It presently gives off two great arteries, which turn upwards along the joint; one round the outer side, the other round the inner side, of the joint. Then it passes downwards, turns in behind the femoral artery, sinking deeper and deeper towards the backparts of the thigh. It passes down along the face of the triceps muscle; and as it moves along its forepart, it sends through three or four great arteries to the backpart, which are called the perforating arteries of the thigh. And, lastly, the profunda itself, or its last branches, passes through the triceps; and this last branch is named perforans ultima vel descendens femoris.

## ARTERIA CIRCUMFLEXA EXTERNA.

THE CIRCUMFLEX ARTERY, which goes to the outside of the hip-joint, proceeds from the very highest point of the profunda. It takes its course outwards, passing under the sartorius, fascialis, and head of the rectus: it runs over the tendinous head of the vastus internus, where that muscle takes its rise from the outer trochanter: it divides very early into the following branches—First, Branches go to the inner side, to the internal iliac muscle, upon which this artery lies; and round it they bend over the lesser trochanter, making inosculations with the internal circumflex artery.—Secondly, An artery goes in the opposite direction, viz. outwards, to the iliac muscle, the sartorius, the head of the rectus, the fascialis, and round to the glutæal muscles.—Thirdly, It sends many lesser branches upwards and forwards into the heads of those muscles which I have just enumerated, and which lie immediately over the artery.—Fourthly, It sends large branches round the root of the great trochanter, some of them going into the hollow above the trochanter; others keeping so low as the root of the trochanter, where the greater glutæus is inserted.—Fifthly, The most important of all its branches is a very long one, which it sends directly downwards under the rectus, or betwixt it and the vastus internus muscle. This artery is divided into two great branches, which run down the whole length of the thigh, somewhat resembling in their shape the PROFUNDA HUMERI: they are named the greater and lesser descending branches



of

of the circumflex artery, and they inosculate in a most particular manner with a large anastomosing branch from the femoral artery. The larger branch of this artery emerges from betwixt the rectus and vastus externus, a little above the knee, to inosculate with one of the articular arteries of the knee. Its smallest branch inosculates with the anastomosing branch of the femoral artery. The two anastomoses seem to be the chief use of these two long arteries, though they do also send some branches to the muscles.

But to give a more simple notion of this circumflex artery, it should be described thus. Is is divided into three chief branches: 1st, A descending branch, which goes down to the knee-joint; 2nd, A transverse branch, which crosses the upper part of the thigh, and turns round the neck of the thigh-bone; 3dly, It sends a less important branch up upon the dorsum ilii.

## ARTERIA CIRCUMFLEXA INTERNA.

The internal circumflex artery is a thick short artery, which goes off opposite to the ball of the thigh-bone; and as the external one goes round the great trochanter, this goes round the lesser trochanter. It is a smaller artery; it has not so many muscular branches; it keeps closer to the joint; it goes off from the inner side of the profunda, just opposite to the circumflexa externa, or a little lower, but never more than an inch lower; it passes over the insertion of the psoas muscle, and under the belly of the pectinalis; it attaches itself then to the lesser or inner trochanter, and goes round the neck of the thigh-bone

roun

round the joint, and is expended on the muscles at the back of the joint, as the quadratus femoris, gemini, &c.

The artery having turned towards the inside, the muscles which lie there are the triceps gracilis, &c. The first branches, therefore, which this artery gives off before it passes under the pectinalis, are to the triceps and gracilis. After having passed under the pectinalis, and while it is turning round the root of the lesser trochanter, it gives branches to the pectinalis and triceps; and especially it gives to the capsular ligament of the hip-joint an artery which is named articularis acetabuli.

The artery now lying upon the pelvis, under the neck of the thigh-bone, divides itself into two chief arteries; one goes upwards and forwards along the triceps, till it ends at last round the symphysis pubis. The chief muscular twigs of this branch are given to the triceps, and to the obturator muscles; it is this branch which inosculates so freely with the branches of the obturator artery; it is a twig of this artery which enters into the cavity of the hip-joint, by that breach which is in the inner edge of the acetabulum; and this branch entering then by its proper hole, goes to the gland in the bottom of the socket, or chiefly to it. The other branch turns away in the opposite direction, viz. backwards betwixt the little and the great trochanter, turning round the neck of the thigh-bone. It gives branches also to the triceps and obturator, inosculating with the obturator artery. But its chief branches are towards the other side, as to the capsule of the hip-joint, to the neck of the thigh-

 bone,

bone, to the quadratus femoris. It is this artery which gives most of those branches about the roots of the trochanters named trochanteric arteries; and it is from this artery that many branches go backwards along the tuber ischii, to unite with those of the sciatic and pudic arteries.

### OF THE PERFORATING ARTERIES.

The two first perforating arteries are very large; the two next perforating are smaller and less regular; the fifth perforating artery is just the termination of the profunda. But still it must be understood, that these perforating arteries are extremely irregular in place, size, and number, as indeed all muscular arteries must be; and that there are, besides the greater perforating arteries, many like them in this part of the thigh, though not distinguished by name.

### ARTERIA PERFORANS PRIMA.

The first perforating artery is the largest branch of the profunda, bigger than both the articular arteries joined. It arises from the profunda, just under the lesser trochanter, betwixt the pectinalis and triceps brevis; and perforates the triceps about an inch below the trochanter, and close upon the thigh-bone. Here the artery lies under the lower edge of the glutæus, and close by the origin of the biceps, semi-tendinosus and semi-membranosus muscles, the three muscles which form the hamstrings; and the chief division of the artery is into one great branch, going upwards along the glutæus, and another going downwards

downwards along the flexor muscles. First, The artery which goes upwards turns over the glutæus, spreads innumerable branches about the great trochanter; and meeting with the trochanteric branches of the arteriæ reflexæ, make a most beautiful inosculation, or rather net-work of inosculations, over the trochanter. Another transverse branch of this upper artery turns quite round the lower part of the trochanter, and round the thigh; among the flesh of the vastus internus; and a third branch of the same artery meets in inosculation with the lower branches of the sciatic artery.

The lower or descending branch of the perforans prima goes down along the three flexor muscles of the leg, viz. the biceps, semi-tendinosus, and semi-membranosus; nourishes their fleshy bellies, and plays over their surface in beautiful net-work.

### ARTERIA PERFORANS SECUNDA MAGNA.

The second or great perforating artery is a much larger and more important branch of the profunda than this first, at least it is so when the other perforating branches are wanting, and when this, as often happens, represents the continued trunk of the artery: but I shall describe it as a second perforating artery, to be succeeded by others *. The second perforating artery comes off from the profunda, about two inches lower than the first; it passes through betwixt the first and second heads of the triceps, or

* My reason for saying this is, that sometimes there are but two perforating arteries, while there are often five which need to be described.

through the flesh of the second; and turning obliquely downwards and backwards, close by the thigh-bone, it passes into the cellular interstice betwixt the flexor muscles of the opposite sides, i. e. betwixt the bellies of the hamstring muscles, and ends there.

Before it passes through the triceps, it gives branches to the triceps, and vastus, and to the great trochanter, and to the thigh-bone. Its two chief branches, after it perforates the triceps, are, first, one great transverse branch, which goes directly across below the tendon of the glutæus, and gives one great branch up upon the glutæus, and another to the vastus externus, making inosculations with the reflected arteries of the joint. Secondly, Its descending branch goes down in the hollow betwixt the great hamstring muscles, and its branches go into both muscles, but chiefly into the biceps, and in these the artery is exhausted.

### ARTERIA PERFORANS TERTIA.

THE THIRD PERFORATING ARTERY comes off about a finger's breadth lower than the former; it makes a gentle waving turn inwards before it pierces the triceps; and after having perforated the triceps, it gives its branches to both the hamstring muscles, but chiefly to the semi-tendinosus.

### ARTERIA PERFORANS QUARTA.

THE FOURTH PERFORATING ARTERY may be regarded as the last, or as the termination of the profunda, though sometimes there is a fifth. It perforates again still lower, about a finger's breadth below the last,

last, through the flesh of the triceps magnus. Its first branch, while on the forepart of the triceps, is the nutritia magna femoris, or proper nutritious artery of the thigh-bone; and after it perforates the triceps, it gives its arteries to the two hamstring muscles, but more especially to the biceps; and so this last branch of the profunda ends.

But this minute description of any important set of arteries never presents any clear idea to the reader's mind, nor any knowledge which he can easily retain. I expect rather to do so by one short description.

The title of PERFORATING ARTERIES is one which comprehends all the great muscular branches of the profunda, except the two reflex arteries belonging to the joint. They vary in number, as all muscular branches must do, and are proportioned in size and number to the bulk of the thigh. The profunda passes down along the forepart of the triceps, while it is giving off these arteries; they must, of course, perforate the triceps before they can get to the back part of the thigh. When they do perforate, they come into a great muscular interstice or hollow, which is formed by the hamstring muscles of opposite sides, by the biceps on one side, and by the semi-membranosus and semi-tendinosus on the other. It is to these two great muscles of the back part of the thigh that the branches of all the perforating arteries are chiefly directed. Each perforating artery succeeds another at about the distance of an inch or more; each successively coming out into this interstice at a lower and lower point. Each artery gives branches to the triceps, &c. before it perforates, and to the hamstring

muscles,

muscles, &c. after it has come into the hollow. The two first perforating arteries are the only arteries which are large and absolutely certain; the third is always very much smaller; the fourth is generally the termination of this great artery; the fifth perforating artery is rare.

Such a general idea as this of their size and value, and situation in the very heart or deepest part of the thigh (for the profunda turns backwards from the very first, and all its branches keep the same direction), is of more importance than a particular knowledge of every branch of each perforating artery; a thing really unattainable, since they vary more in their ultimate branches than almost any other arteries in the whole body; for they have more space, and a greater mass of irregular muscle to wander in, and produce varieties.

### ARTERIA FEMORALIS.

Though the profunda is plainly the artery of the thigh, yet from the ignorance of anatomists and surgeons (who never knew till about twenty years ago that there was more than one great artery) the superficial artery has been named the artery of the thigh.

The femoral artery makes a spiral or serpentine turn round the whole thigh. It appears first on the forepart; it turns obliquely round to the inner side, following the lower edge of the sartorius muscle; it passes through the triceps, after it has got about two-thirds down the thigh, by which it gets into the ham, and its spiral turn is completed. It lies deep where it is giving off the profunda; it rises then, and is superficial

perficial all along the middle of the thigh; and when it has advanced two-thirds down the thigh, it again gets too deep to be felt; but all along it is covered by the thick strong fascia of the thigh. Through the whole of this course it gives no one branch out that is of any considerable importance. They are all muscular arteries, very small, nearly of one size, nameless, and undistinguished, going into the muscles of the forepart of the thigh; or if any are distinguished, it is only by their relation to other arteries, when the trunk gets low enough to make anastomoses with the arteries of the joint.

The nameless muscular branches of the Femoral artery, go, in one word, to all the muscles on the forepart of the thigh; to the rectus, sartorius, vasti, gracilis, and triceps; to the glands, fascia, fat, and skin; and it thus continues giving successive branches to each of these long muscles as it passes the several points of them.

There is no distinguished branch till, having arrived within two hands' breadth of the knee-joint, it gives out (just where it is about to pass through the tendon of the triceps) a larger branch named (like a similar branch of the humeral artery) RAMUS ANASTOMOTICUS MAGNUS.

This branch goes out from the inner side of the femoral artery just where it is about to perforate the triceps; it passes into the flesh of the vastus internus; it first sends smaller branches to the vastus internus and sartorius, and through the interstice of these two muscles to the skin of the knee. But having penetrated into the fleshy belly the vastus internus, this artery,

artery, which is itself very short and thick, sends out its slender inosculating branches: one goes downwards along the tendon of the great triceps; and when the tendon of that muscle stops above the inner condyle, this artery goes forwards over the condyle, makes a net-work upon it, joining in numberless inosculations with the articular arteries from below, and gives twigs also into the joint. The other branches of this ramus anastomoticus tend all forwards and upwards to join the descending branches of the reflexa externa, which come down along the rectus muscle.

There are two other arteries lying close upon the joint, remarkable enough to deserve a name, and they are called perforating arteries; not perforating like the branches of the profunda, to get deeper among the flesh; but perforating so as to get out from the cavity of the ham upon the surface of the thigh again.

The UPPER PERFORATING ARTERY arises from the inner side of the popliteal artery, just after it has perforated the triceps; but it must not be accounted a popliteal branch, because it immediately perforates the triceps muscle again. It gives branches to the semi-tendinosus, semi-membranosus, and sartorius; in short, it turns it branches towards the muscles on the inner side of the knee, and is a smaller astery.

The LOWER OR SECOND PERFORATING ARTERY goes off nearly opposite to this. It is a much larger artery. In order to escape from the ham, it perforates the shorter head of the biceps, or outer hamstring muscles. It first crosses the ham at its very upper point, and within the substance of the triceps; it then perforates

forates the shorter head of the biceps flexor-cruris; it then emerges upon the thigh by the belly of the vastus externus muscle. Before it crosses across the ham, it gives a branch to the semi-membranosus: while it is passing through the flesh of the biceps, it gives a lower nutritious artery to the lower and back part of the thigh-bone; after it perforates the biceps all its branches are to the flesh of the biceps and vastus externus, and its extreme branches are spent in inosculation with the descending branch of the reflex or articular artery of the hip-joint.

But these branches, which are the last of the femoral artery, are extremely irregular. There is no artery from the profunda downwards worth naming, not even those which I have just described*.

## POPLITEAL ARTERY.

The artery having passed through the ring or tendon of the triceps which is formed for it, or rather having passed betwixt the triceps and the bone, lies flat against the flat part of the thigh-bone as deep as possible in the cavity of the ham. There, as no muscles are lodged, it can give no muscular arteries of any

* "Confiteri tamen oportet, binos ultimos ramos in distribuendis suis surculis infinite ludere, ita ut descriptione ad quod cunque cadaver adaptata vix, ac ne vix quidem comprehendi possint. Ex repetitis tamen meis dissectionibus id pro certe habeo, duos vel tres, quos perforantes appellare vellem, exoriri, hos trunculis suis ad externum latus præcipue conflecti cumque rete vasculoso genu jungi, nutritiant inferiorem ex iisdem gigni, et ramos insuper nunc pauciores, nunc numerosiores, communicantes ad flexores cum profunda elevari." *Arvidson*, p. 36.

any importance; none but trivial ones to the ham-strings or to the heads of the gastrocnemii. In its whole length from the place of its perforating the triceps tendon to its great division, which is under the longer head of the solæus muscle, it gives none but articular arteries, i. e. small arteries to the knee-joint, which are no less than five in number, and encircle it in all directions.

First, The popliteal artery sends off from each side two muscular branches, not deserving a particular name nor description; the one goes to the biceps or muscle of the outer hamstring, the other to the semi-tendinosus and sartorius, or inner hamstring muscles.

Then come off the arteries of the joint, which are thus arranged: 1. The upper arteries coming off above the joint are three in number; one turning round the inner side of the joint, and one round the outer side, and one in the middle; whence it is named azygous, as having no fellow. 2. The arteries below the joint are two only in number; one to the inner side, and one to the outer side, of the joint; and these directions of the arteries settle both the order of description and also their names.

### ARTERIA ARTICULARIS SUPERIOR EXTERNA.

THAT upper articular artery which comes off above the knee, and which turns round the outer side of the joint, arises from the popliteal artery above the outer condyle; its trunk is like all these arteries about the joints, short and stumpy; but its branches long and slender. It passes under the flesh of the biceps; it

it appears again at the edge of the vastus externus: one branch plunges into the vastus externus, mounts upwards, and besides supplying the muscle, inosculates with the long descending branch of the reflexa externa; while another branch turns as directly downwards over the face of the outer condyle, and spreads beautifully over the side of the joint, inosculating in many net-works with the corresponding artery from below.

### ARTERIA ARTICULARIS SUPERIOR INTERNA.

THE UPPER ARTICULAR ARTERY of the INNER side goes off in like manner over the inner condyle, pierces the tendon of the triceps, where it is implanted into the condyle, and passing under the edge of the vastus internus, turns towards the forepart of the knee, proceeds towards the patella, and covers chiefly the inner side of the joint with its net-work of inosculations; its little twigs slip in under the great lateral ligament, and under the sides of the patella to the cavity of the joint itself. It inosculates like the outer artery with the lower arteries of its own side.

### ARTERIA ARTICULARIS MEDIA.

THE MIDDLE OR AZYGOUS ARTICULAR ARTERY usually arises from the back part of the popliteal artery, but sometimes from one or other of those last described; but this branch, at all events, is seldom wanting. It runs down behind the main artery upon the back part of the joint, into the great hollow betwixt the condyles; and all its branches are expended upon the back of the capsule, the posterior

crucial

crucial ligament, the semilunar cartilages, and the fat about the back of the joint.

### LOWER ARTICULAR ARTERIES.

The lower articular arteries are more slender, longer run downwards very low, and return upwards with a very sudden angle.

### ARTERIA ARTICULARIS INFERIOR EXTERNA.

The external ARTICULAR ARTERY below the KNEE goes off from the popliteal at the middle or centre of the joint, turns downwards along with the popliteal artery for a considerable way; it passes under the heads of the small plantar muscle and the outer head of the gastrocnemius, and having passed through, encounters the head of the fibula, and passes above it to the side of the joint, spreading its branches towards the patella.

In the ham this artery gives muscular branches to the heads of the muscles, as of the gastrocnemius, solæus, plantaris, and the popliteal muscle, that muscle which lies obliquely across the ham. When it reaches to the side of the joint, it passes under the external lateral ligament; and several of its branches, besides their external anastomoses, go into the cavity of the joint, one of which within the joint is especially large.

### ARTERIA ARTICULARIS INFERIOR INTERNA.

The INTERNAL ARTICULAR ARTERY below the knee is larger than the external one. Like it, it bends downwards, passes under the inner head of the gastrocnemius

mius muscle, crosses behind the head or rather neck of the tibia, on the inner side of the knee. It first gives arteries to the back of the joint; then it communicates downwards with a large recurrent artery from the tibialis antica; it inosculates upwards with the articularis superior interna; it contributes (as all the other articular arteries do) to the forming of that profuse net-work of arteries which is spread over the whole of the capsule of the knee-joint. It sends also, like the others, certain twigs, which creep under the internal lateral ligament, and go into the cavity of the joint along the borders of the semilunar cartilages.

Those who write on aneurisms of the ham talk much of these arteries. They compare them with the recurrents of the arm; and think, when they see five articular arteries, that it is a sure sign that at such a point all is safe; when really these arteries cannot be of the smallest service. They are all destroyed by the long compression of the popliteal aneurism, or are ingulphed in the bag of the aneurism. If they ever appear, it is not as inosculating arteries, ensuring the safety of the limb; but as small branches bursting into the sac, embarrassing the operator, and confounding every thing, sometimes filling the sac a-new with blood, after all was thought to be quite safe, and the patient laid in bed.

Before the popliteal artery passes under the head of the solæus, it gives two long arteries, which run down upon the two heads of the gastrocnemii muscles. It often also sends small twigs to the head of the solæus, and to the popliteal and plantar muscles.

# OF THE THREE ARTERIES OF THE LEG AND FOOT.

THE three arteries are, the tibialis antica, going on the forepart of the leg; the tibialis postica, passing deep along the back part of the leg; and the peronea, which is the smallest and least regular artery of the leg, and which has its name from passing down behind the fibula.

The popliteal artery divides below the ham, under the longer head of the solæus muscle, into two arteries, the tibialis antica, and tibialis postica. The tibialis postica continues its natural direction downwards under the solæus muscle, and behind the tibia.

## ARTERIA TIBIALIS ANTICA.

THE TIBIALIS ANTICA makes a sudden turn forwards, perforates the interosseous membrane just under the lower edge of the popliteal muscle; passes out towards the forepart of the leg, betwixt the heads of the tibia and fibula: but still it does by no means become a superficial artery; on the contrary, it lies deep betwixt the heads of the tibialis anticus and the extensor of the toes; and is covered here with a very strong fascia. It is only about six inches above the ankle that the leg grows tendinous and naked; there this anterior artery can be felt beating: it lies betwixt the tendons of the tibialis anticus muscle and that of the extensor of the toes; it passes down along with these tendons, through the annular ligament, and over the bones

bones of the tarsus; it sends one branch across the foot, another forward to the great toe: but the artery itself dives betwixt the first and second metatarsal bone in the middle of the foot, and so gets to the sole, where it ends in inosculations with the back arteries.

There is here something like a posterior recurrent artery; for the tibial artery, before it passes out of the ham, gives a small branch which ascends towards the back part of the joint, and is distributed to the heads of the bones, viz. the tibia and fibula, and to the origin of some of the muscles.

### ARTERIA RECURRENS.

There is here an ANTERIOR RECURRENT, larger than any in the arm, and much resembling the recurrens interossea. It is a branch which comes off from the forepart of the tibial artery, instantly after it has perforated the interosseous membrane; it turns immediately upwards under the flesh of the tibialis anticus; it gives many muscular branches, some to the head of the tibialis, others to the upper part of the extensor digitorum, and branches go round the head of the fibula to the origin of the long peronæus muscle. One branch goes directly upwards, and spreads all over the lower part of the knee-joint, mixing its branches in the common vascular net-work.

The tibialis antica gives no other branch of importance, or which should be named, even from the place of this recurrent quite down to the ankle-joint; for this, like the radial, or femoral, or any long muscular artery, continues giving off branches from either

hand to the muscles betwixt which it runs, of equal size nearly, and all equally unimportant. The tibial artery, then, as it runs down the forepart of the leg, gives branches to the Tibialus Anticus on one hand; to the Common Extensor of the toes on the other hand; and to the Extensor of the great toe, which is the last of the three muscles that occupy the forepart of the leg. It also gives little arteries to the tibia, to the fibula, and to the interosseous membrane which lies betwixt them; but still it arrives unexhausted at the forepart of the ankle-joint.

But before it crosses the joint (which it does by passing obliquely along with the tendon of the great toe), it gives out two malleolar arteries, i. e. two arteries, one to the outer, and one to the inner ankle.

### ARTERIA MALLEOLARIS INTERNA.

THE ARTERY of the INNER ANKLE goes off just where the head of the tibia begins to bulge. It turns over the inner ankle in many small branches; some mounting upwards along the tibia, but more going downwards over the inner side of the joint, i. e. over the tibia or inner ankle over the astragalus, and some down as low and as far backwards as the heel-bone.

### ARTERIA MALLEOLARIS EXTERNA.

THE ARTERY of the OUTER ANKLE goes off a little lower down. It sends smaller branches upwards round the outer ankle, which go to the Peronæus Brevis muscle, to the joint, and to the common extensor of the toes, inosculating round the outer ankle with the fibular arteries. But its chief branch descends along

the

the forepart and outer side of the foot, gives twigs to the short extensor of the toes, and ends in inosculations with the tarseal arteries, or arteries belonging to the forepart of the foot.

The arteries which belong to the forepart of the foot are usually three in number: One goes off from the tibial artery a little above the ankle-joint, and is named Arteria Tarsea, because it crosses the foot over the bones of the tarsus. To this succeeds a second about the distance of half an inch from it, and which crosses the foot at the place of the metatarsal bones; it is named Arteria Metatarsea: and the one or other of these gives the interosseous arteries, accordingly as the one or the other is small or wanting. The third is that remarkable branch which goes forwards along the great toe, whence it is named Arteria Halucis.

### ARTERIA TARSEA.

The tarseal artery, which is sometimes of a very considerable size, almost equal to the tibialis itself, comes off a little below the ankle, upon the forepart of the foot. It lies upon the second rank of the tarsal bones; it passes under the head of the extensor brevis of the foot; it crosses the foot obliquely, so as to end in the abductor muscle of the little toe, and in inosculations with the arches of the sole of the foot.

This branch gives small inosculating arteries upwards, which first give branches to the joint, and then join with the external malleolar and peroneal arteries. Next it gives branches to the bones and joints of the tarsus, which it lies upon; as the cuboid and cuneiform bones, and their joints. Thirdly, It gives small

arteries to the bellies of the extensor brevis, where it lies under it.

But its greatest arteries are the interosseous arteries, which it sends along the interstices betwixt the metatarsal bones. These interosseous arteries are three in number; they run along in that interstice which holds the interosseous muscles; and when they arrive at the end of that furrow, or, in other words, at the place of the forking of the toes, each interosseous artery turns down to the sole of the foot, and goes into the fork of each digital arch, on the lowest side of the toes. Sometimes these arteries give also small dorsal arteries to the backs of the toes.

The tibial artery having proceeded along the tarsal bones, and arrived at the lower heads of the metatarsal bones, and having first given off some trivial branches to the joints of the foot on its inner side, and to the bones and muscles about the root of the great toe, next gives off a metatarsal artery*.

### ARTERIA METATARSEA.

THE ARTERY of the METATARSUS or instep goes off at the head of the first metatarsal bone. It bends across the roots of the metatarsal bones to the root of the little toe; and it distributes branches to the tendons of the peronæi muscles, and ends in the abductor of the little toe, and in the skin over the outer

* N. B. Betwixt the tarsal and metatarsal artery, there is usually a small branch going outwards to the outer edge of the foot, i. e. in the same direction with both these arteries, but very small.

edge

edge of the foot. But sometimes it is a larger and more important artery; for when the tarsal artery is small or wanting, this metatarsal one gives off the interossei, and supplies its place.

### DORSALIS EXTERNA HALUCIS.

The third branch is the ARTERY of the BACK of the GREAT TOE.' This artery is of very considerable size; it gives no muscular branches, because it lies upon the bony part of the foot; it runs all along the metatarsal bone which supports the great toe; and it ends at the forking of that toe in two great branches; one the dorsal artery of the great toe, which goes along it to the point; another to the side of the toe next the great toe, which it also runs along, somewhat like the forking arteries of the thumb and fore-finger.

The anterior tibial artery ends here (i. e. where it gives off the artery of the great toe). By sinking in betwixt the metatarsal bones of the great toe and of the toe next to it, and going directly into the arches of the sole of the foot, it produces a great and important anastomosis, similar to that of the radial and ulnar arteries.

### ARTERIA TIBIALIS POSTICA.

The POSTERIOR TIBIAL ARTERY is so named from its passing along the backpart of the tibia. The anterior tibial artery passes through the interosseous membrane only at the lower edge of the popliteal muscle: this artery comes off from the general trunk at the upper edge of the popliteal muscle, and passes obliquely

towards the inside of the tibia, to take its place behind that bone. Its whole situation and general course is this: It lies over the tibialis posticus and flexor muscles; it lies under the bellies of the gastrocnemius and solæus; it turns round the inner ankle close upon the bone. Having passed the lower head of the tibia, it goes down along the inside of the heel-bone, in its deep arch, upon which the body is supported; it divides at the heel-bone, and advances along the sole of the foot in two great branches; one running along the sole, next the outer edge of the foot; the other along the inner edge of the foot; whence they are named external and internal plantar arteries. From this arch the artery gives branches to all the toes, and so it ends.

This posterior artery is chiefly a muscular one, at least in its course down the leg; and though it gives many branches as it passes along, there are hardly any worthy of being described: and from the knee to the ankle-joint there is one only which needs be distinguished by name, viz. the artery which nourishes the tibia.

First, The tibialis postica often gives arteries to the heads of the gastrocnemii muscles; next it gives off the ARTERIA NUTRITIA TIBIÆ, which begins a little below the lower edge of the popliteal muscle, runs downwards along the interrosseous ligament, gives muscular branches to the popliteus, solæus, and tibialis posticus, and then sends the nutritious artery into the great hole in the middle of the tibia. It gives many branches to the periosteum of the tibia, and to the interosseous membrane all down the leg, and it ends

near

near the lower end of the tibia in inosculations with the peroneal artery.

Other nameless muscular arteries succeed to this, going to the tibialis posticus, to the flexor communis, and to the flexor of the great toe. When the artery arrives near the ankle-joint, it gives many small twigs to the periosteum, tendons, sheaths, and bursæ mucosæ behind the ankle; and then passing in the very deepest part of the ankle, under the annular ligament, and betwixt the tibia or process of the inner ankle and the heel-bone, it adheres closely to the bones and capsule of the joint; and there gives a great many little tortuous arteries, making net-works over this joint and its bones, as over the other joints already described. But especially two delicate arteries go out at this hollow at the side of the heel-bone: one forwards towards the side of the ankle-joint, the other downwards and backwards over the heel-bone, which ramify very profusely and very beautifully.

The artery now lying deep under the abductor magnus of the great toe, which arises from the heel-bone, forks into its two great branches, the external and internal plantar arteries.

### ARTERIA PLANTARIS INTERNA.

THE INTERNAL PLANTAR ARTERY is much the smaller branch, not to be compared in importance (though their names are contrasted) with the external plantar artery; and it is named internal, because as it runs along the sole of the foot it keeps to the inner edge, viz. that to which the great toe belongs. It comes off under the head of the abductor of the

great

great toe, and under the belly of that muscle, and close upon the bone; its branches run forwards, quite up to the root of the toe, all along its metatarsal bone. The internal plantar artery has in general four branches, which all run pretty nearly in the same direction, viz. straight forwards.

It gives, while under the head of the abductor, small branches, which go backwards to the joint, its capsule, and tendons, and some into the spongy substance of the heel-bone; some also to the short flexor of the foot, and to the massa carnea. But its four greater and more regular branches are these:

The first lies nearer the inner edge of the foot; is the largest and most considerable; it runs along under the inner border of the abductor; it goes quite up to the ball of the great toe, and unites with the proper artery of the toe. As it goes along it gives small twigs to the periosteum and bone.

The second resembles the former, except that it does not come off so early by two inches; it is of course shorter, but it passes along in the same direction, only a little distant from the first, lying along the middle of the metatarsal bone. It also advances up to the root of the great toe, and runs also into the proper artery of the great toe (which comes from the external plantar branch), so as to enlarge and strengthen it.

The third lies still nearer to the centre of the foot, and deeper among the muscles. It runs the same general course, viz. along the side of the metatarsal bone up to the ball of the great toe, and ending like the others in the artery of the great toe; but as it lies deeper, it gives branches to the short flexor, to the

tendons,

tendons, and to the inner surface of the aponeurosis plantaris, forming a sort of superficial arch.

From these three arteries, much of the skin on the sole of the foot has its branches.

The fourth and last branch of the plantaris interna, is one which goes down deep into the centre of the foot; it lies close upon those ligaments which bind together the bones of the tarsus, and under all the tendons, except those of the tibial muscles which are like ligaments to the bones. Its destination is chiefly to the tarsal joints and capsules; its inosculations with the external plantar artery can be of no importance.

### PLANTARIS EXTERNA.

THE EXTERNAL PLANTAR ARTERY is the great artery of the sole of the foot, from which the arches of the foot and the inosculations with the anterior tibial artery are formed.

It turns outwards towards the outer edge of the foot; it runs its great circle round by the metatarsal bone of the little toe; and its plantar arch, or the arch of the sole of the foot, passes over the middle of all the other metatarsal bones. It receives the anterior tibial artery under the middle of the matarsal bone of the great toe. It is this great curve of the artery turning round in the sole of the foot that we name the plantar arch; and it is from it that all the proper arteries of the toes arise, expressly after the same order in which the fingers receive their arteries.

The great or external plantar artery lies deep, but not upon the naked bones like the former. It passes through betwixt the heads of the short flexor and

massa

massa carnea; it turns its first turn outwards, till it gets under the flexor and abuctor of the little toe; then it turns inwards towards the centre of the foot, and lies under the tendons of the long muscles, and over the metatarsal bones and their interosseous muscles.

First it sends a large branch backwards to the heel-bone, which belongs entirely to that spongy bone, forms, like all such arteries, a sort of net-work over all the surface of the bone; it first touches the bone under its extreme point, or that which rests upon the ground; and it goes branching over it so high as to inosculate round the ankle with twigs of the tibialis antica; it gives branches also hereabout to the great ligament of the heel-bone. The external plantar artery next gives branches to those muscles betwixt which it lies imbedded, viz. the massa carnea and flexor brevis; then advancing to the side of the flexor digiti minimi, it gives out two or three branches, which first go into the flesh of the abductor and flexor of the little toe, and then turning over the edge of the foot, terminate in inosculations with the arteries of the fore-part of the foot and in the skin.

It then begins from the root of the metatarsal bone of the little toe to form that great circle which is named the arch of the foot, and which gives out two ranks of arteries: First, Of interosseous arteries going to the spaces betwixt the metatarsal bones upon which the toes stand; and, Secondly, The proper arteries of the toes themselves.

The first of these arteries proceeding from the tarsal arch is a small one, the artery of the little toe. It begins at the lower head of the metatarsal bone, lies under

under the flexor and abductor muscles, gives branches to these muscles and to the skin, and to the bone itself; it runs up the outer edge of the little toe, and this is immediately succeeded by the first interosseous artery; which lies deeper, passes along the first interosseous space, gives branches to the bones and interosseous muscle, and inosculates betwixt the toes with the branches of the anterior tibial artery.

The next artery is properly the first of the great arch. It is what is called the RAMUS DIGITALIS, or proper artery of the toes. It is a long artery, runs over the interosseous space lying upon the interosseous muscles; it advances to the root of the little toe, and like those of the fingers divides into two branches, one to the inner side of the little toe, and the other to the side of the toe next it.—A second and a third DIGITAL ARTERY go out in the same manner, and split at the roots of the toes into two branches, and with so little variety that it is needless to describe each part.

In the interstices of each of these arteries lie two or three small perforating arteries, which perforating betwixt the metatarsal bones inosculate with the interosseous arteries which lie on the forepart of the foot.

But the great external plantar artery, while it is giving out these arteries alternately, i. e. large branches to the toes, and smaller twigs to the interosseous muscles, and some smaller still which go off from the concave part of the arch, and go into the sole of the foot to the ligaments and joints; the great artery goes still onwards, and completes its arch at the middle of that metatarsal bone which supports the great toe. There, a little behind the ball of the great toe, it receives

ceives the tibialis antica, which perforates from the forepart of the foot. This completes the arch of the anterior and posterior arteries, and permits the blood to pass, according to the pressure or other accidents, in either direction; and this union strengthens and enlarges the artery of the plantar arch so much, that it is not exhausted by the many branches which it has given off, but gives at this point the largest artery of all, viz. the artery which supplies the great toe and one side of the toe next it. This artery of the great toe is the very last or extreme branch of the aortic system. It very closely resembles the great artery of the thumb; it gives out three chief branches, viz. one to each side of the great toe, and one to the inner side of the toe next it. This ARTERIA POLLICIS PEDIS sometimes seems to proceed entirely from the perforating branch of the anterior tibial artery; at other times it arises fairly from the plantar arch.

### ARTERIA PERONEA.

THE FIBULAR ARTERY, or the third artery of the leg, which is much smaller than these two, is to be regarded rather as a branch of the anterior tibial artery; and in its course and connections, and its being exhausted nearly by the time it reaches the ankle-joint, it greatly resembles the interosseous of the fore-arm, which stops below the wrist, or passes it only with small and extreme branches.

Where the tibialis antica passes through the interosseous ligament, the arteria peronea breaks off from it, almost of equal size with itself, and passes down behind the fibula, whence it has its name. It arises near

near the head or origin of the tibialis posticus muscle, and accompanies that muscle down to the ankle-joint, lying betwixt it and the flexor of the great toe.

This is entirely a muscular artery for supplying those deeper parts which the other arteries do not supply. Its branches, like those of all muscular arteries, are extremely irregular; its chief branches are to the solæus, to the peronæi muscles, to the tibialis posticus, to the flexor of the great toe. Several little arteries turn round the fibula from point to point, going to the fore-part of the leg. All the way down the leg, it is giving off repeated branches to the same muscles; and in this course it gives some little arteries, which pierce through the interosseous membrane, and also gives the nutritious artery of the fibula.

When it approaches the ankle-joint, the fibular artery gives off an anterior branch, which perforates the interosseous membrane, passes through betwixt the tibia and fibula nearly where they are joined; it turns downwards over the outer side of the ankle, by the extensor pollicis and peronæus brevis tendons. This is named PERONEA ANTERIOR, though it is an artery of little importance. Its branches are given not to muscles, for this is a naked and bony part of the foot; but are expanded upon the lower heads of the tibia and fibula, and upon the os cuboides. They nourish the tendons, ligaments, and bursæ of the outer ankle; they end in inosculations with the malleolar artery, from the tibialis anterior, and with the tarsal artery.

ARTERIA PERONEA POSTERIOR.

As this ANTERIOR FIBULAR ARTERY branches over the fore-part of the outer ankle, the POSTERIOR FIBULAR ARTERY passes deep behind the same ankle, and is just the continuation of the main artery; which having passed down behind the acute angle of the fibula, sinks into that deep hollow which is behind it upon the side of the heel-bone. Behind the tibia the artery makes large inosculations with the posterior tibial artery, and gives many branches to the tendons. Branches also turn round the ankle, making a network of vessels upon it, and inosculating with the anterior tibial artery. It continues to give the same small arteries to the outer ankle, to the peronæi tendons, to the outer side of the heel-bone, and to the abductor of the little toe. It ends usually in that muscle, and in inosculations with that branch of the external plantar artery which turns backwards upon the heel-bone and ramifies upon it so beautifully.

These are the last branches of the three great arteries of the leg and of the aortic system.

FINIS.

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